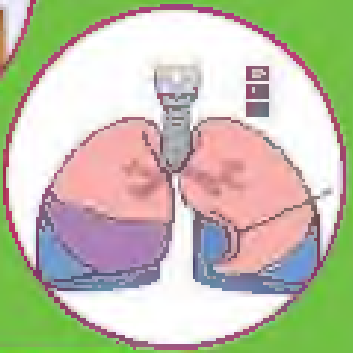
SCIENCE 8

FOR CLASS VIII

Test Edition



SINDH TEXTBOOK BOARD

Printed by

Prepared and produced by the Sindh Textbook Board, Jamshoro
Reviewed Directorate of Curriculum, Assessment Research Jamshoro, Sindh
Approved by the Education and Literacy Department, Government of Sindh, No: SO (GM) SELD/3-910/19 dated: 5-7-2019, for the students of the Province of Sindh.

Patron In Chief
Mr Agha Sohail Ahmed
Chairman Sindh Textbook Board Jamshoro

AUTHORS

- Ms Shahrose Irfan Jessani
- Ms Afshan Kafeel
- Mr Laeeq Ahmed
- Ms Suraya Yousufi
- Mr Syed Rehan Ali
- Ms Ume-Farwah Halai

REVIEWERS:

- Ms Unaeza Alvi
- Mr Mustaque Ahmed Shaheni
- Sayed Saleh Muhammad Shah
- Mr Sarwaruddin Jamali
- Ms Tahseen Latif
- Mr Piaro Khan Saharan
- Dr. Ali Asghar Khaskheli

EDITOR:
- Mr Noor Ahmed Khoso

CO-ORDINATOR:
- Mr Daryush Kafi

PROOF-READING
- Mr Muhammad Ayoob Juneja

Printed at:

Table of Contents

Preface

It is a matter of great pleasure and satisfaction for me to iterate that the Sindh Textbook Board has been providing the students of the entire Sindh province, with textbooks of worthy standard from the point of its inception, till now. On one hand, these books are quite affordable; on the other hand, their publication and availability is being managed in a timely and efficient manner.

The main ideology behind these textbooks is that they must contain knowledgeable, qualitative material in order to impart in our students, the skills that can help them compete in today's ever changing and challenging world. The present global scenario demands that first and foremost, our new generation must be well conversant with the Islamic ideology; then it must possess an exemplary character, a high degree of patriotism, and a sense of responsibility, brotherhood, fraternity and equality. The possession of all these qualities will assist them in their studies in general. However, acquisition of these skills is all the more important particularity in science teaching and learning, if the students are to actively participate in new scientific research and inventions, and develop awareness, soundness of mind and a progressive mind set.

Our students will be able to achieve success and economical stability and lead a prosperous and successful life, only when they are able to master these skills. Along with these skills our students will have to develop inquiry, communication, critical thinking and problem solving skills for a bright future. Having a bright future, they will be able to ultimately hold the reins of their country and provide it the much needed prosperity and economic soundness. They will become model citizens of their country and nation in shape of learners, implementers and innovators.

With objectives and intentions of such noble national spirit, the Sindh Textbook Board is introducing this book of **"Science Grade-8"** for new entrants in the field of education. This book has been written by well-experienced authors and reviewed by senior educationists in accordance with the "New Curriculum 2006" for inclusion in the syllabus. Thus, the Sindh Textbook Board is quite hopeful that the teachers, students and other respective stakeholders will benefit from this book.

Lastly, it is requested that in case there are any concrete recommendations(s)/suggestions from your side with reference to the material contained in this book, feel free to convey them to us, so that they can be incorporated in the subsequent edition.

The Chairman
The Sindh Textbook Board, Jamshoro.

بِسْمِ اللّٰهِ الرَّحْمٰنِ الرَّحِيْمِ

CHAPTER 1

HUMAN ORGAN SYSTEM

In the previous classes we have studied human digestive and respiratory systems. Do you know how these systems are controlled? Which organ system is responsible for recognizing and remembering things? How do you understand things? How do waste products are secreted from the body? The body system that controls and coordinates for the function of all other organ systems is called Nervous System. For example, when nervous system gives signal to the excretory system it helps to remove metabolic wastes from the body. Let us explore the structure and functions of these amazing systems.

In this Chapter you will learn about:

- Nervous System (Central and Peripheral)
- Reflex Action
- Excretory System (Structure of Kidney and its Role in Excretion)

All the students will be able to:

- ✓ Describe the structure and functions of the nervous system.
- ✓ Describe the working of the nervous system through a model.
- ✓ Explain reflex action with an example.
- ✓ Differentiate between voluntary and involuntary actions they have experienced.
- ✓ Define excretion.
- ✓ Draw and label human excretory system.
- ✓ Describe the role of kidney in the excretion of waste.
- ✓ Investigate the possible causes of the malfunctioning of kidneys.
- ✓ Suggest techniques to cure problems of kidneys.

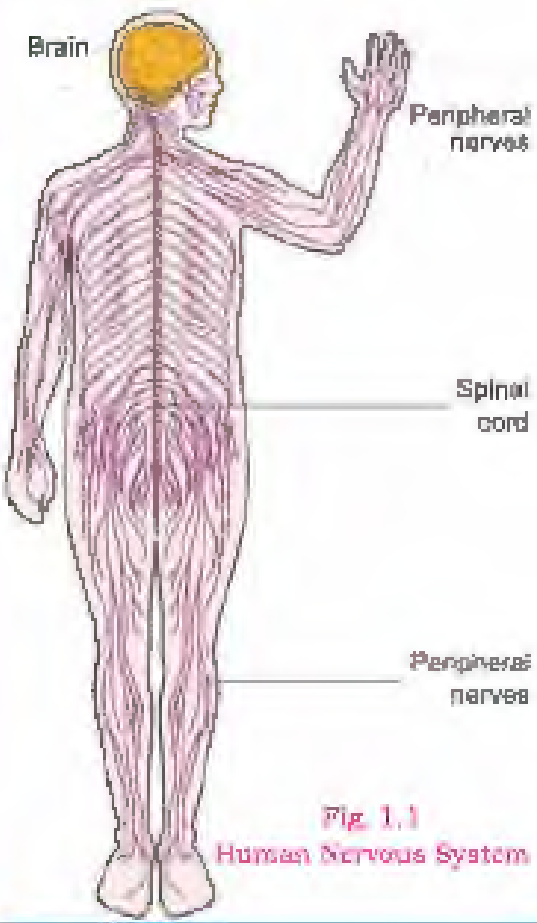


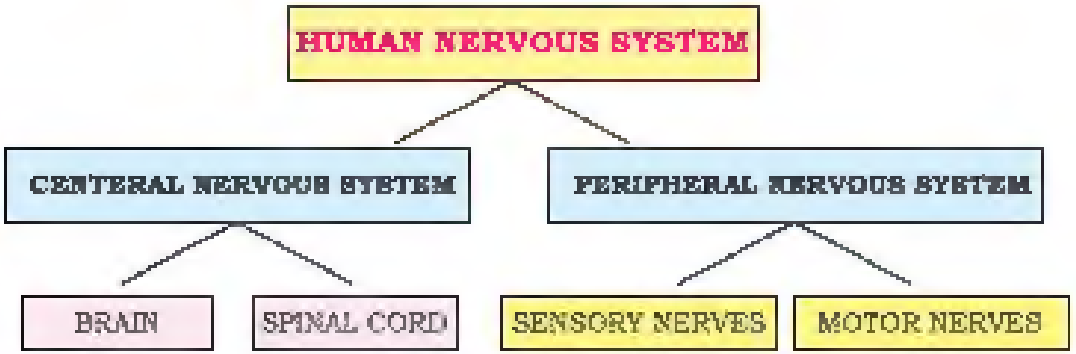
Fig. 1.1
Human Nervous System

NERVOUS SYSTEM (CENTRAL AND PERIPHERAL)

➢ Describe the structure and functions of the nervous system.

The nervous system is a network of nerves that links brain to every part of the body and allows them to work together. It is our body's communication system. It is divided in two parts:

1. The Central Nervous System (CNS)
2. The Peripheral Nervous System (PNS)



1.Central Nervous System (CNS)

The central nervous system is composed of the brain, spinal cord and nerves. It controls all the vital functions necessary for living such as breathing, maintaining body temperature, thinking, feelings and heartbeat.

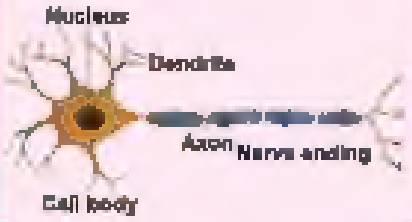
A) Brain

Have you ever seen a brain? Do you know that the structure of brain is very similar to the structure of walnut as shown in Fig. 1.2. Let's discuss the human brain.

Brain is enclosed in a hard-bony protective structure called cranium (skull). Brain is made up of soft nerve

DO YOU KNOW?

Nervous system has the responsibility to communicate, and coordinate for the body functions. It has specialized nerve cells called neurons, which are the basic structural and functional units or building blocks of the nervous system.



tissues and appears like a large pinkish grey walnut. Brain has folds and depressions which give it wrinkled appearance. It is the most amazing part of our body which serves as control centre of the human body. It receives messages from all parts of the body and gives orders to control the activities of different parts of the body. Brain is always working even while sleeping. Brain consists of three parts.

Fig. 1.2: Walnut

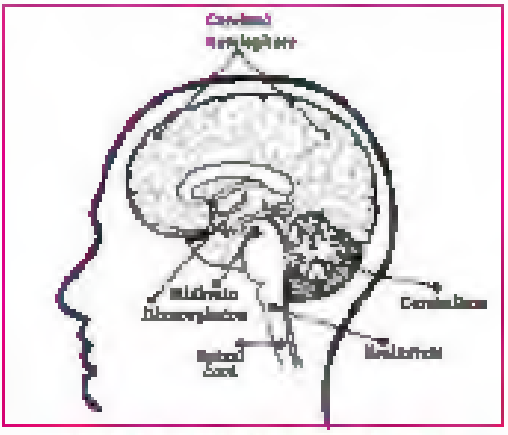


Fig. 1.3: Parts of human brain

i) Fore Brain or Cerebrum: It is the largest part of the brain and comprises two hemispheres. Right hemisphere controls the left side of the body and left hemisphere controls the right side of the body. Cerebrum controls many actions like thinking, feelings, memory, hearing, seeing, speech, decision making.

Fig. 1.4: Fore Brain

Thalamus: It lies inside cerebrum and controls sensory functions.

Hypo-thalamus: It lies at the base of the thalamus and controls the body temperature, feeling of hunger and thirst.

ii) Mid Brain: The midbrain consists of the optic lobes. The optic lobes are four small bodies. These are concerned with visual reflexes, e.g. movement of the eyeballs.

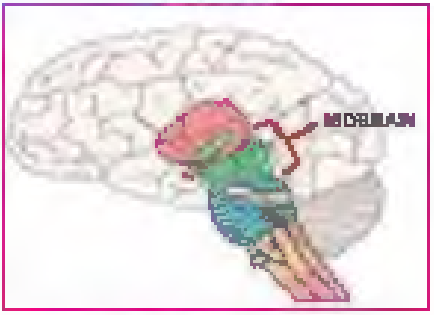


Fig 1.5. Mid Brain

iii) Hind Brain: The hind brain consists of three parts:

- **Pons**
- **Cerebellum**
- **Medulla oblongata**

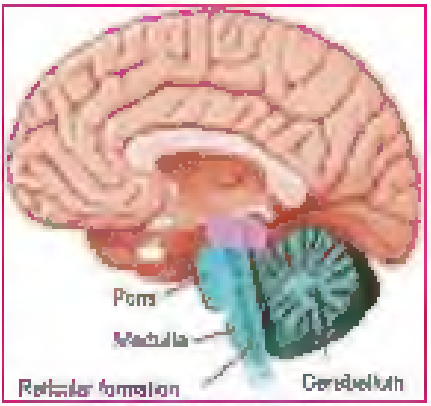


Fig 1.6: Hind Brain

The **Pons** is a bridge-like structure which links different parts of the brain. It conveys signals from the medulla to the higher parts of the brain. Pons also controls facial expressions, sleeping and breathing.

The cerebellum lies dorsally behind the optic lobes. It is large, and its surface contains many folds. The cerebellum plays an important part in controlling muscular co-ordination, and especially in maintaining the body balance.The medulla Oblongata lies below the cerebellum. Its lower end narrows down gradually into the spinal cord.

The medulla oblongata controls involuntary reflex actions such as blood pressure, heart beat, peristalsis, the rate of respiratory movements and the contraction and dilation of blood vessel.

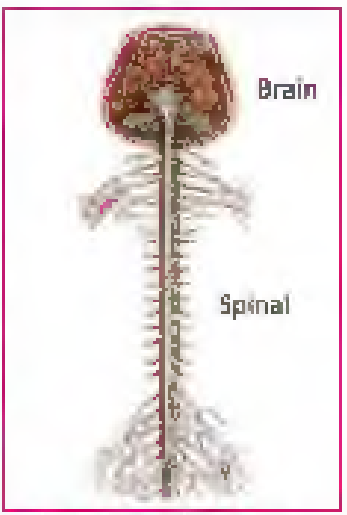


Fig.1.7: Spinal Cord

B) Spinal Cord

The spinal cord is a long piece of nerve tissue that runs from the brain through the backbone within the vertebral column. In fact it is the extension of the brain through the vertebral column. It receives sensory information from back parts of the body. The brainstem (Medulla Oblongata) connects the brain to the spinal cord while spinal cord

connects the brain to the body's nerves. Spinal cord helps regulate and control functions which are not under the control of persons' will such as breathing, heartbeat, blinking, and blood pressure.

C) Peripheral Nervous System

The peripheral nervous system consists of nerves that branch out from the central nervous system to the rest of the body. It acts as the lines of communication between the Central Nervous System and the rest of the body.

Nerves are of two types, one type of nerves carries messages to the brain and spinal cord; these are called sensory nerves. The second type of nerves carries messages away from brain or spinal cord to the organs; these are known as motor nerves.

The function of the cerebral cortex can be understood by dividing it into four zones such as:

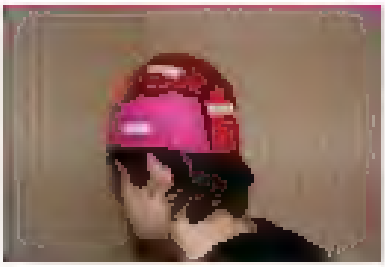
1. **The frontal lobe:** is responsible for initiating and coordinating motor movements; higher thinking skills, such as problem solving, planning, reasoning, movement, and organizing; and for many aspects of personality.
2. **The parietal lobe:** is involved with sensory processes, attention, and language. The right side of the parietal lobe helps in navigating spaces. The left side helps to understand spoken and written language including recognition of shapes and colors.
3. **The temporal lobe:** helps to process auditory information and integrate information from the other senses. Temporal lobe plays a role in short-term memory formation.
4. **Occipital lobe:** helps process visual information, including recognition of colours. All of these structures make up the fore brain.

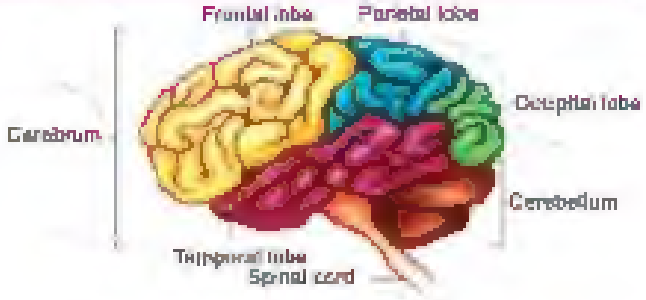
In order to enhance your understanding about structure of nervous system associated with senses such as touch, pressure, temperature and pain, now perform this simple activity which will convert your abstract ideas into concrete understanding.

ACTIVITY 1.1

Understanding the Structure of Brain:

Studying a real human brain is not possible at this level. Teacher can help students to relate the learning with their own body. This activity may help students to visualize the major section of human brain. Teachers can provide a white tight cap and ask students to locate different zone of the brain on the cap.





What I need:

- A diagram of Brain as shown above (one for each group).
- A black marker and markers of different colours for drawing 4 zones, spinal cord and cerebellum (one set for each group)
- White cap made up of cloth/ swimming cap/ bath cap (1 for each group) (teacher can also prepare a paper/ cloth cap).
- Glue/Scotch Tape.

What to do:

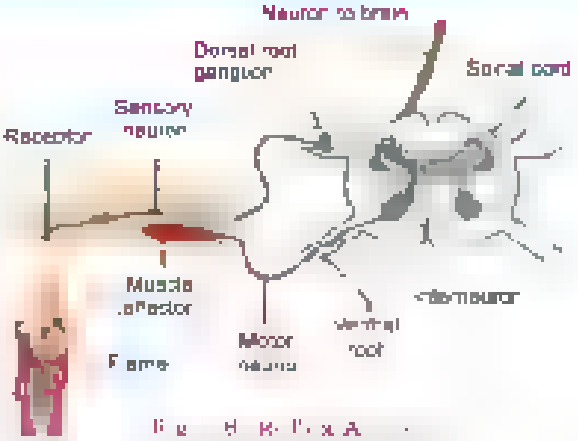
1. With the help of a black marker, mark different zones on the cap as shown in the figure.
2. Use different colour markers to show different zones (frontal, parietal, lateral, occipital) cerebellum and medulla oblongata.
3. Teacher can wear the cap to demonstrate her/his brain portions.
4. One student from the group should wear the group's cap to show and explain other group members about different parts of brain. Turn by turn each group member will do the same.

DO YOU KNOW?

The brain is responsible to process the information collected by the body and senses. It controls and regulates important processes, such as breathing. You should care for your brain and senses by wearing seatbelts and helmets while travelling.

✓ Explain Reflex Action with an example

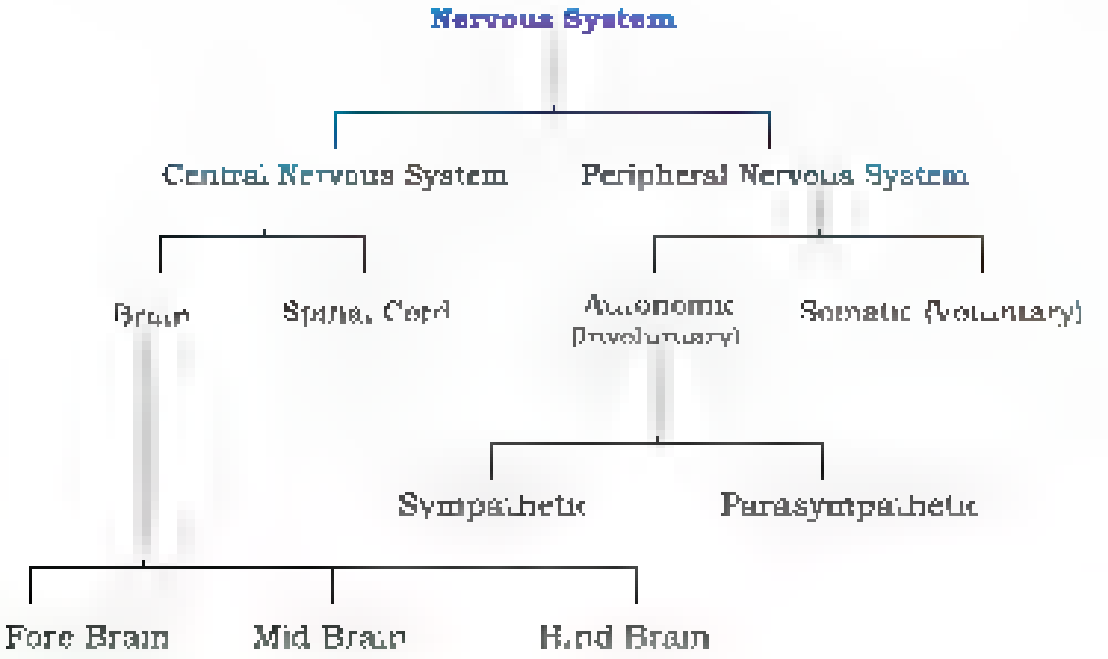
The quick action in which brain is not involved is called a reflex action. If you accidently touch a hot pot on your stove, you will immediately pull your hand away from the pot. This quick response is called a reflex action. Such types of actions are automatic and superfast performed by the body in response to a sensation. They are controlled by nerve messages that work even before person thinks about them. It means our all actions are not ordered by brain. Nerves in our hand detect the heat and shoot a message to nerve centre in the spinal cord. The nerve centre immediately sends back a message to the hand to draw itself away. This happens within fraction of a second. Closing the eyes quickly if an object suddenly approaches it, withdrawing the hand when pricked coughing and sneezing are natural reflex actions.



DIFFERENCE BETWEEN VOLUNTARY AND INVOLUNTARY ACTIONS

✓ Differentiate between Voluntary and Involuntary Actions they have experienced

Voluntary or Conscious Action	Involuntary or not under conscious control
• These actions are performed according to our wish • We have experienced eating, bathing, walking, running and doing all that day to day activities that involve complex work in brain • Fore brain is responsible for voluntary actions	• Most of the biological processes in animals are involuntary which occur without conscious control or will • Breathing, blinking of eyes, contraction of the heart, blood flow and digestion are involuntary actions because we cannot alter their course of action • Hind brain is responsible for involuntary actions



EXCRETORY SYSTEM:
STRUCTURE OF KIDNEY AND ITS ROLE IN EXCRETION

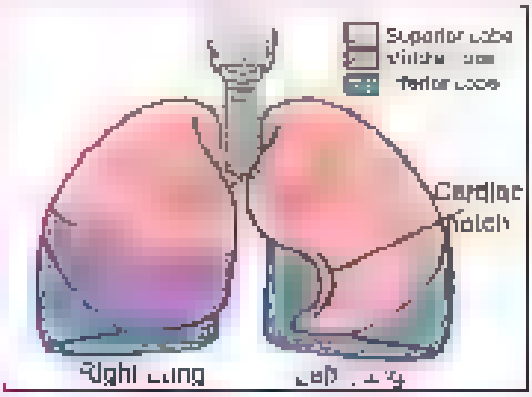
➢ Define Excretion

In the previous class you have studied human digestive and respiratory system. It is now time to recall your previous knowledge. Have you ever thought what happens to the undigested food and the carbon dioxide gas produced as part of digestion and respiration respectively? What will happen to our body if these waste materials remain in our body? How do we get rid of these waste materials? What happen to water that we drink? How do we eliminate liquid waste from our body? What is the function of kidneys? Let us explore.

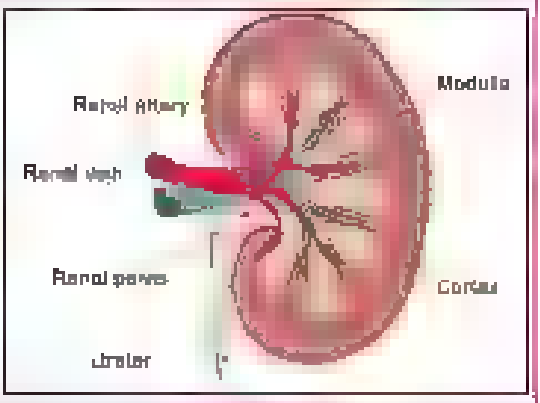
The excretory system is critical to survival. The trillions of living cells in the human body produce metabolic wastes which must be eliminated from the body. If the wastes aren't eliminated, it might lead to death. The process of eliminating these waste materials from the body is known as excretion of waste.

DO YOU KNOW?

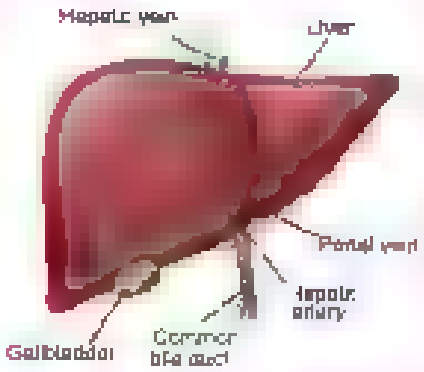
There are four organs which play an important role in eliminating waste material from our body. These are : 1. Lungs 2. Kidneys 3. Liver 4. Skin



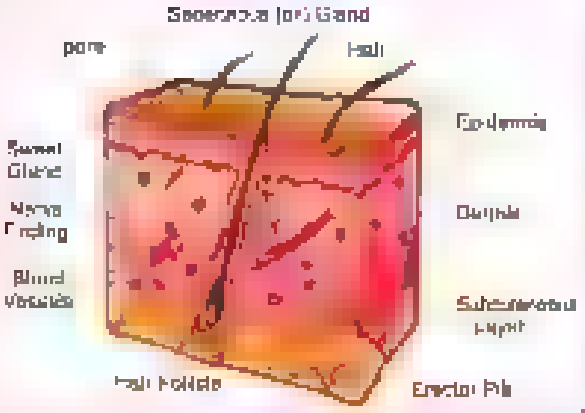
LUNGS



KIDNEY



LIVER



SKIN

DO YOU KNOW?

What are the waste materials that being excreted from the human body?

- **Water** is a product of cellular respiration and excess water absorbed from food in the large intestine
- **Carbon dioxide** which is a waste material from the process of cellular respiration
- **Mineral salts** such as excess sodium chloride from food
- **Urea** that is nitrogenous material produced from the breakdown of excess protein in the liver

THE HUMAN EXCRETORY SYSTEM

- Draw and label Human Excretory System

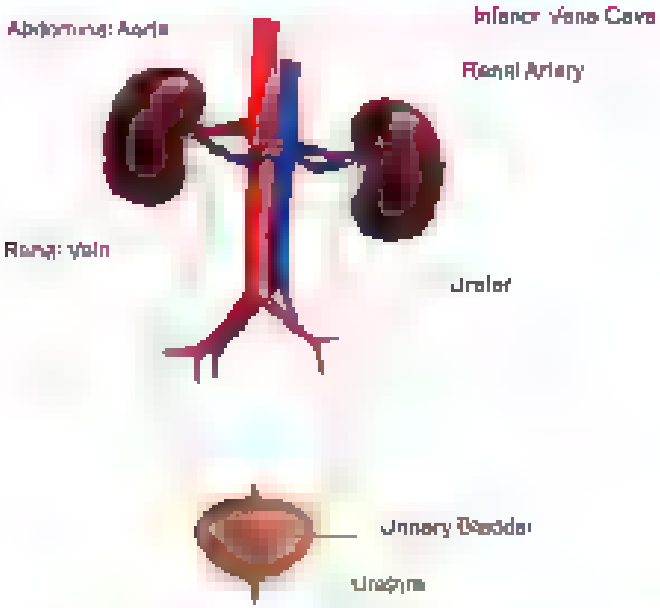


Fig. 1.9 The Human Excretory System.

THE ROLE OF KIDNEY

- Describe the role of kidney in the excretion of waste

In the previous chapters you studied that as part of human digestive system, undigested food was expeded out from the body through large intestine. Similarly during respiration Carbon dioxide and water are eliminated through blood circulatory system, body transport system and respiratory system. It is important to note that all the systems in human body are connected and interrelated to perform body functions. so the different waste material especially excess water, metabolic wastes and salts are removed from body. Here, we will study in detail the main organ of excretory system that is kidney.

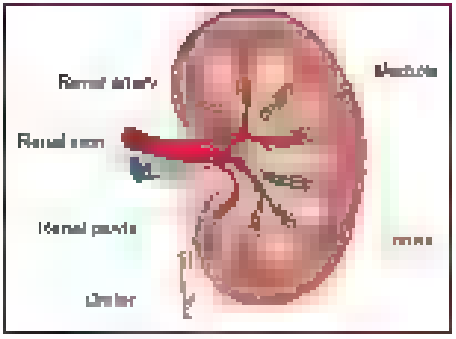


Fig. 1.10 Kidneys

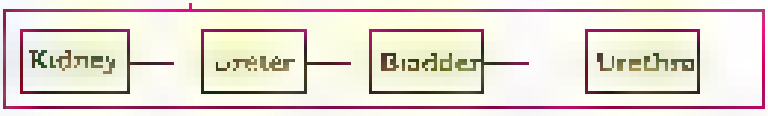
Kidneys are essential organs in human excretory system. There are two kidneys on the lower abdominal region, one on either side of the vertebral column, which are left kidney and right kidney. The kidneys are bean-shape and are reddish brown. When it is full, the excretory product eliminates out of the body through the urethra. This excretory product is discharged in the form of yellow-coloured liquid known as urine.

How does Kidney Function

The renal artery transports blood to the kidneys. This blood is rich in water, urea and dissolved mineral salts. Each kidney has about a million tiny units called nephrons. Nephrons take in blood, metabolize nutrients and help pass out waste products from filtered blood.

In the nephron, a complicated chemical exchange takes place between capillaries and urine-carrying tubes. As a result waste materials and water leave blood and enter urinary system.

Urinary System



The excretory product removed from each kidney passes through the ureter to the urinary bladder. The urinary bladder functions to store this excretory product temporarily. When it is full, the excretory product will be eliminated out of the body through the urethra. This excretory product is discharged in the form of yellow-coloured liquid known as urine.

KIDNEY MALFUNCTION

- ✓ Investigate the possible causes of Kidney malfunctioning
- ✓ Suggest techniques to cure problems of kidneys

Kidney failure happens when they do not work properly. This could be due to some underlying diseases such as diabetes, hypertension

or infections caused by microorganisms. A blockage in ureter and urethra in the form of calcification or stone can cause damage to the kidneys because urine cannot flow out of the body. A person who has only one kidney still can live normally. If both kidneys fail, the person will have to rely on an artificial kidney machine called the dialysis machine to remove wastes from the blood.

Dialysis

- The process of filtering and cleansing the blood outside the body is called Dialysis. It is done by using a dialysis machine which purifies blood by two distinct processes 1. filtration and 2) reabsorption.
- Dialysis removes excess water and wastes through a semi-permeable membrane (which allows certain substances to pass through it but not others) and works on the principle of osmosis and diffusion.
- A semi-permeable membrane has pores which allow urea and salts to pass through.
- Larger particles such as blood cells, bacteria, viruses or protein cannot pass through this membrane.
- The common dialysis method is hemodialysis where waste products and excess water are separated artificially from the patient's blood.

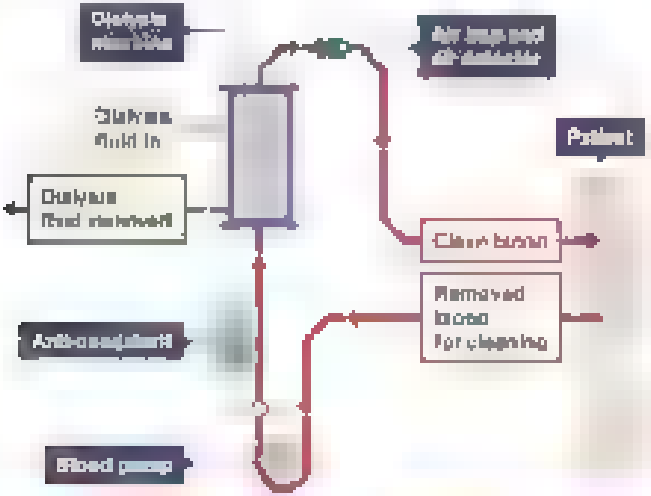


Figure. 1.13 Process of Dialysis

Kidney Transplant

The acute renal failure can be managed by kidney transplant. In a kidney transplant a healthy kidney received from a donor is placed inside the body to do the work which cannot be done by patient's own kidney.

DO YOU KNOW?

Role of Sindh Institute of Urology and Transplant (SIUT): Sindh Institute of Urology and Transplantation (SIUT) located in Karachi, Pakistan is one of the most reputed medical institutions in the South Asian region. SIUT is providing free of cost specialized treatment and transplant procedures of kidney and liver patients. This all have been possible with selfless leadership and spirit of service for humanity by Dr. Adeeb ul Hassan Rizvi.

SUMMARY

- Main control system of our body is Nervous System.
- It consists of three main parts 1. Brain 2. Spinal Cord 3. Nerves.
- Brain an organ of soft nerve tissue is located in upper part of bony head called skull.
- Brain is divided into three parts 1. Cerebrum or fore brain 2. Cerebellum or mid brain 3. Hind brain.
- Pons and Medulla Oblongata with the mid brain are often called the brainstem.
- The human nervous system serves three main functions 1. collect information from sense organs. 2. Integrate information by processing and evaluation 3. decide to take action.
- Water, Carbon dioxide and metabolic waste like Urea are body wastes which are expelled from the body.
- The main organ of the urinary system includes the Kidney and its functional unit the nephron.
- The water and urea are expelled out in the form of urine through the Ureter.
- The kidney can be damaged due to microbial infection, calcification and other diseases.
- The kidney disease or failure can be managed through dialysis and kidney transplant.

EXERCISE

1 Fill in the blanks

Upper part of the body head is called
Top part of the brain is known as_____
Cerebellum means_____
Hind brain consists of pons and_____
The largest part of the brain is_____
Extension of the brain through vertebral column is called
The waste material from the process of cellular respiration is
The main excretory organ is
The artificial kidney machine is called
Acute kidney failure can be managed by

2. Circle the best answer

The nervous system is network of

a) Neurons b) spinal cord c) nerves d) lobes

i) Fore brain is called

a) Cerebellum b) Cerebrum c) Medulla Oblongata d) Pons

The central nervous system is composed of

a) Cerebrum Thalamus and Hypothalamus

b) Cerebrum Pons and Medulla oblongata

c) Brain, Spinal cord and nerves

d) Cerebellum, Brain and nerves

v) The main excretory organ is:

a) Kidney b) liver c) skin d) lungs

Replacement of malfunctioning organ by a healthy organ is called

a) Transformation b) Transplantation

c) Transpiration d) Translocation

3. Answer the following question

What does nervous system do? How does it transmit messages between the brain and the body?

List some of the things your nervous system controls in your body.

Nervous system has three main parts. What does each part do?

Name the parts of the brain which control movement, thinking, emotion, breathing, growing and temperature?

Describe the functions of

1. The frontal Lobe
2. The parietal Lobe
3. The Temporal Lobe
4. Occipital Lobe

Differentiate between voluntary and involuntary movements.

Give five examples of reflex action related with daily life.

Why does the body need an excretory system?

Explain the role of kidney in the excretory system.

Draw and label Human Excretory system.

PROJECT WORK

- Compare brain with computer. Discuss with your classmates.
- Visit your nearby hospital and interview a neurologist to find out the common brain disorders in the area and discuss some ways to cure them. Also, find the rate of death due to brain injuries in road accidents.
- During your visit, interview some kidney patients to find out the process of dialysis. Also, ask from doctors as how many kidney patients go to kidney transplant per year.

THINK QUESTION

Why Brain is the boss of human body?

Why our brain works all the time and does not stop working during sleeping?

What is the function of spinal cord in Nervous System?

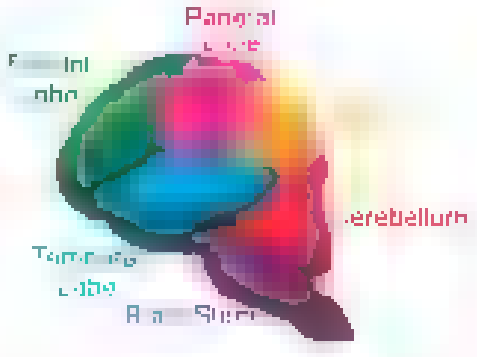
Why do doctors usually suggest liver function test when diagnose the kidney related problems?

People often sweat more while exercising. One reason is because sweating helps us to stay cool. Give another reason for that.

There are people, who have been born with one kidney, yet they are normal. What precaution they should still take?

Activity Making a model of Brain (Group work)

Material Needed. Modeling dough Plaster sheet clay in 5 different colours mix different food colours in it)

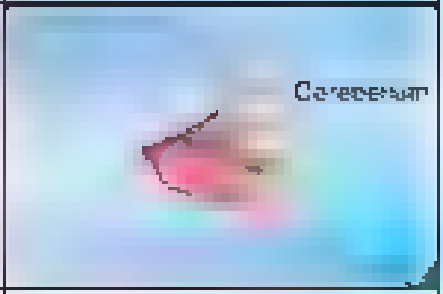


Teacher note Teacher should observe students and make sure that everyone participates actively After the completion of model teacher should ask students to remain in the same group and give whole class presentation on function and structure of nervous system with the help of the model they have prepared Ensure active participation of each group member by dividing the role and responsibilities among group members.

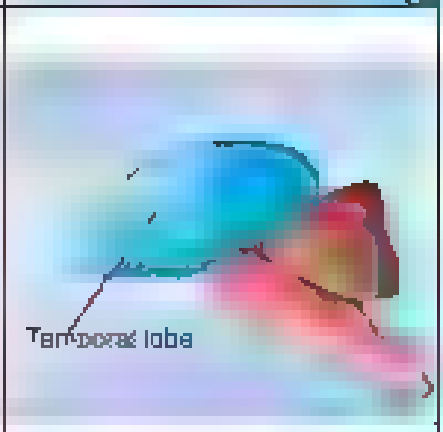
PROCEDURE	DIAGRAMS
Choose 6 different colours of playdough to create a model of the brain as shown in the picture Each color will be used to create different lobes of the brain Using different colors will make it easier for you to separate and identify each part of the brain (Use colours of your own choice)	
The brain stem Take a small amount of playdough clay and roll it between your palms to create a thick rope It should have a slight "s" or elbow shape as shown in the figure Smooth the rope with your fingers until the top of it curves upward and to the	

left while the bottom should be slightly longer than the top section and sink off to the right. The bottom should also have a pointed tip, while the top should have a flat edge and look a bit wider overall.

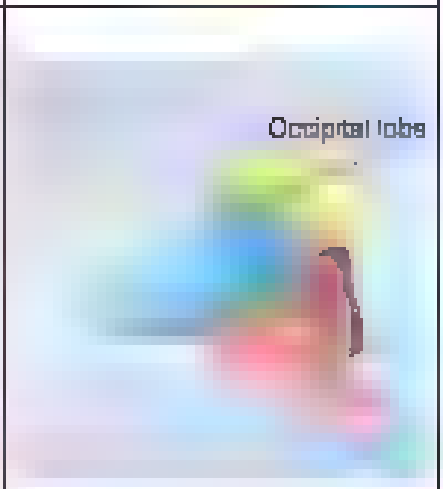
Attach the cerebellum. Take pinch off roughly half the amount you used with creating the brain stem. Roll and form this into a triangle with rounded edges. Position it so that one side of the triangle sits in the upper curve of the brain stem.



Create the temporal lobe. Pinch off a roughly the same size lump of clay you used for the brain stem. Roll this clay into an oval shape. Place the center of this oval onto the top of the brain stem and press it gently to attach the two pieces of clay together. The bottom left half of the oval should reach halfway up the left side of the cerebellum if we consider the bottom of the triangle to be the part matched to the brain stem.

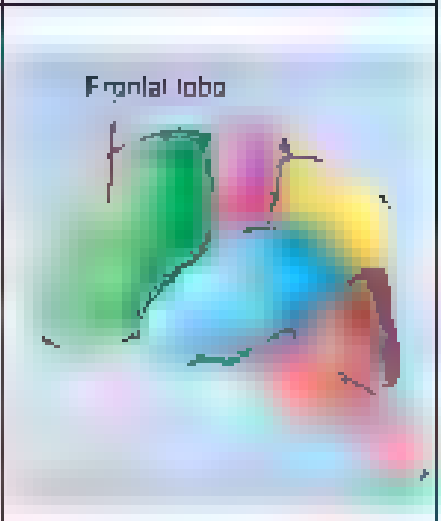


Move on to the occipital lobe. Take a piece of clay roughly the same size as your temporal lobe. Roll and flatten this piece into a quadrilateral which inclines out at the top making a muffin shape. Position it so that the bottom center of the lobe connects to the top left half of the temporal lobe. The right side of the occipital lobe should cover the other left half of the cerebellum with the muffin top spilling slightly over the top of the cerebellum.



Add the parietal lobe Pinch off slightly more clay than the amount used to create your occipital lobe. Form another rectangle just larger than a square. One bottom shorter edge of the rectangle should cover the rest of the right half of the oval made by the temporal lobe. The rectangle should lean slightly to the right.

Make the frontal lobe to complete the atlas This should be your largest bit of clay and slightly larger than your original amount used to create the brain stem. Roll it into an oval, then slightly flatten the bottom right and left sides to attach them to the rest of your brain atlas. Wedge this final piece in place on the left of your model to create the front of the brain. The flattened bottom right section will attach to the parietal lobe, while the bottom left covers the top left half of the temporal lobe oval slightly overlapping the edge.



CHAPTER

2 HEREDITY IN ORGANISMS

In your previous class you have already learnt about structure of animal and plant cell. You know that cells are the basic functional and structural unit of living things. You have also seen that living things undergo growth and development process. Do you know how you and other living things have developed and grown over the years? If you burn yourself, then how do your wounds heal? How do living things reproduce? Why children resemble their parents? You may even have some resemblance with your maternal or parental uncles and aunts or grandparents. Which structure in cells helps living things to grow in the same manner as their parents grow? How characteristics are transferred from parent to offspring? Let us explore these and other related questions.

In this Chapter you will learn about:

- Cell Division.
- Heredity
- Basis of Heredity (Chromosome, DNA and Genes in Plant and Animal Cell)

All the students will be able to:

- ✓ Differentiate between Mitosis and Meiosis
- ✓ Identify DNA and chromosomes in the cell diagram
- ✓ Define Heredity and recognize its importance in transferring of characteristics from parents to offsprings
- ✓ Identify the characteristics that can be transferred from parent to offsprings
- Compare characteristics related to ear and eye colour

Figure 2.1 Nucleus, Chromosomes and Genes

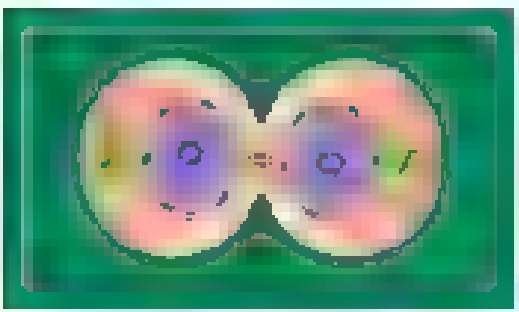


Figure 2.2 Cell division

CELL DIVISION

➢ Differentiate between Mitosis and Meiosis

You know that all multicellular organisms (plants animals and human beings) are composed of more than a billion cells which are the structural and functional unit of life. Cells are continuously dying and are replaced by new cells. The multiplication of new cells takes place by a process known as cell division. The cell division involves nuclear division and cytoplasmic division. The nuclear division is called Karyokinesis followed by division of cytoplasm called cytokinesis. The nucleus mainly takes part in cell division. The nucleus contains a hereditary material called chromosomes which divides and form new cells. The cell that divides is called **parent cell** resulting in producing new cells called **daughter cells**. Before the cell division, the dividing cell undergoes a phase called interphase in which the sets of chromosomes are duplicated in the parent cells.

Cell division takes place mainly by two processes

1. **Mitosis** in which body cells divide for growth, repairing and development
2. **Meiosis** takes place when sex cells are divided and gametes are formed during the process of reproduction in humans other

DO YOU KNOW?

- Nucleus is responsible for cell division because it contains nuclear material called chromosomes.
- Chromosomes are made up of proteins and nucleic acid.
- Famous Scientists and Nobel laureate Francis Crick and James Watson presented the first DNA model in 1953.
- For any organisms, the number of chromosomes present in the cell remains constant. The number of chromosomes present in a human cell is 46.

A. MITOSIS

Mitosis takes place in somatic or vegetative cells as a normal process of growth and development. In mitosis the parent cell divides into two daughter cells with the exact number of chromosomes which are the bearers of the hereditary characteristics. Genes which are responsible for the production of characteristics are found in the chromosomes. Prior to mitosis, interphase occurs as part of cell division. Mitosis consists of four stages **prophase, metaphase, anaphase and telophase.**

i **Prophase** is the first stage when chromatin become thickened, shorten and become visible under a microscope called chromosomes.

ii During **Metaphase**, chromosomes get attached to spindle fibres formed by the two centrioles.

iii In **anaphase**, contraction of spindle fibre takes place resulting the chromosomes to move towards the opposite poles of the cells.

iv **Telophase** is the last stage where chromosomes reach towards their respective poles and followed by the process of cytokinesis resulting in forming two daughter cells. The daughter cells are the exact copy of parent cells with same number of chromosomes.

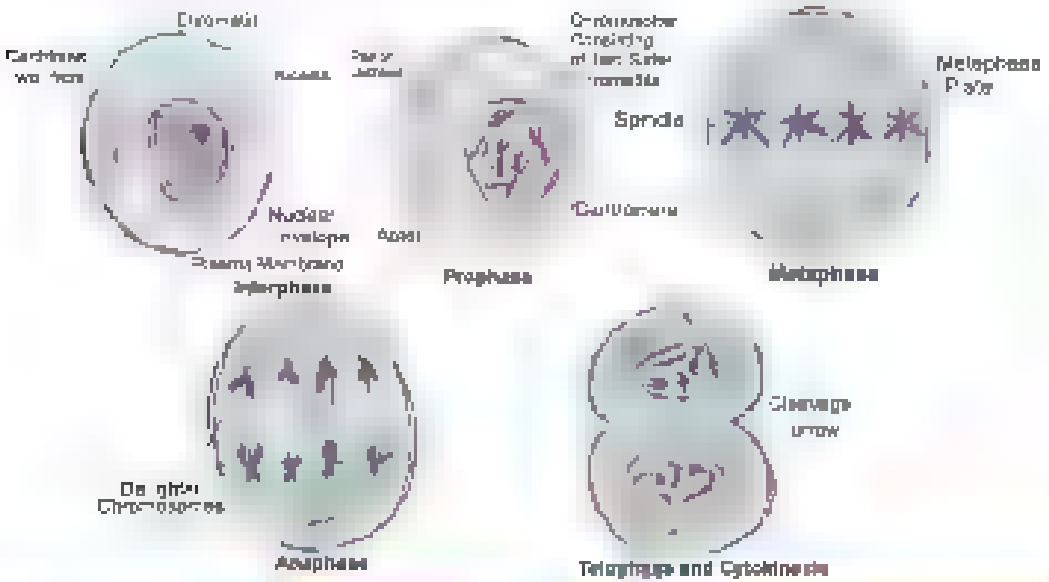


Fig. 2.4 Phases of Mitosis

B. MEIOSIS

Meiosis is also known as a reduction cell division. Meiosis consists of two nuclear divisions, Meiosis I and Meiosis II which are needed for sexual reproduction. In meiosis, the daughter cells produced have half the number of chromosomes (haploid) than the parent cells. Meiosis I is a reduction division in which the number of chromosomes is reduced.

However, meiosis II is similar to mitotic division. The number of chromosome remain the same (haploid) during the formation of four daughter cells. It occurs in sex organs during gamete formation.

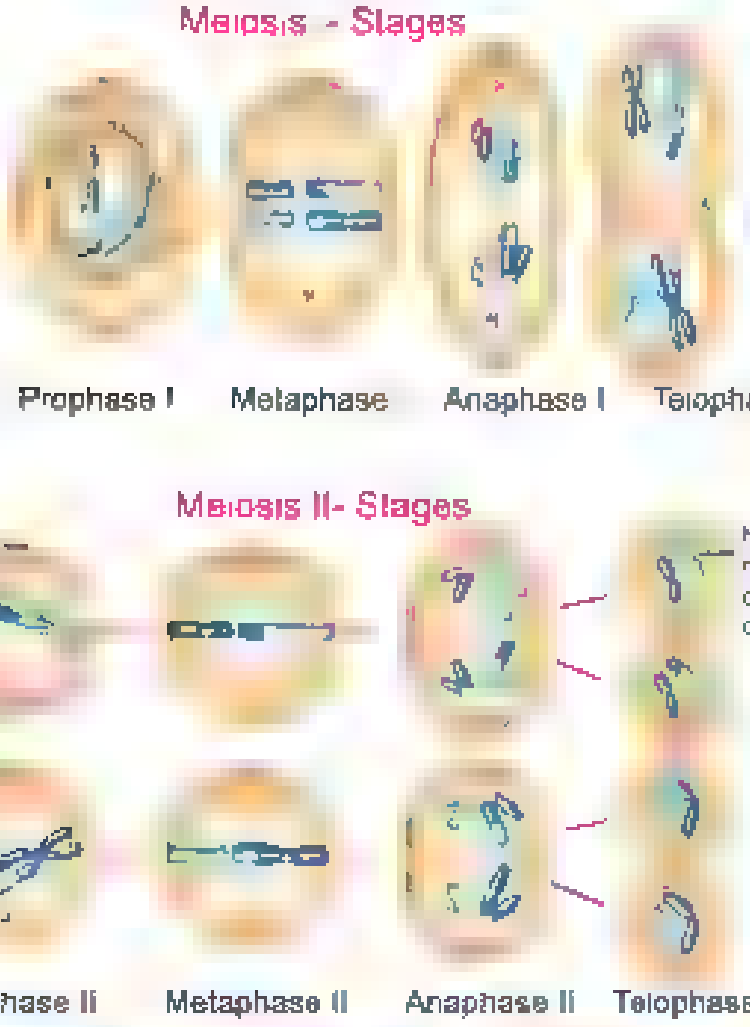


Figure 5: Phases of Meiosis and Meiosis II

Difference between Mitosis and Meiosis.

	Mitosis	Meiosis
1	It occurs in somatic (body) cells, when parent cells divide during growth, repair and development	It is a special type of cell division necessary for sexual reproduction. It occurs in sex organs during formation of gamete (egg/sperm spores)
2	In mitosis, two identical daughter cells having same number of chromosomes out of one parent cell are produced	In meiosis, four daughter cells are produced containing haploid number of chromosomes
3	Mitosis consists of one round	Meiosis consists of two rounds, Meiosis I and Meiosis II
4	Cytokinesis occurs just after Telophase which is the last stage of Mitosis	Cytokinesis or division of cytoplasm takes place in both Meiosis I and Meiosis II
5	Chromosome number remains same	Chromosomes number become half (haploid)

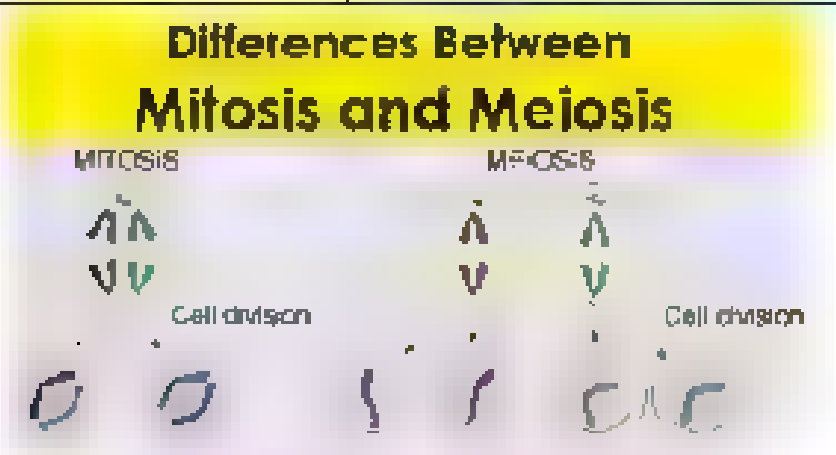


Fig. 2.6 Difference between Mitosis and Meiosis

Teacher should show prepared slides of each phase of mitosis and meiosis under a microscope and ask students to observe and draw the diagrams of every stage in their exercise books. Teacher should ensure that each student observes, draws the diagrams and discusses the difference between Mitosis and Meiosis

Making Model of Mitosis and Meiosis

Activity 2.1

Making Model of Mitosis and Meiosis

Material Required:

- White disposable plates, 12
- Threads of two different colours
- Beads
- Markers
- Scissors

Method

You may use the white plate to represent the nucleus. The threads will represent your chromosomes. The bead will be centromere. You can make the spindle fibre either by thread or a marker.

Activity 2.2 Pair Activity

Take cards of process of Mitosis and Meiosis and shuffle them. Distribute one set of cards to each pair of students. Ask students to arrange the cards in sequence. They should arrange Mitosis and Meiosis in a separate sequence. After completion of activity, teacher should facilitate whole class discussion on correct sequence.

Fig 2 Mitosis and Meiosis

BASIS OF HEREDITY

- Identify DNA and chromosomes in the cell diagram

Do you know what is DNA and where is it located? What does DNA stand for and what is its shape and functions? To understand DNA, let us first explore what is inside the Nucleus or nuclear material.

Chromosomes

Chromosomes are present inside the nucleus as chromatin network. When cell divides, this chromatin network condenses to

Teacher should ask students to draw different stages of Mitosis and Meiosis on separate cards. After completion of the topic they can use these cards for reviewing the topic by Card Sort Activity.

form a typical chromosome consists of two chromatids The two chromatids are attached at the centre to the same centromere Chromosomes in pair also called as homologous chromosomes The number of chromosomes in similar organism is constant

Genes

The basic physical and functional unit of heredity is called gene Genes are responsible for the expression of various characteristics. These genes are located on chromosomes. The genes are arranged on chromosomes in a linear order The number of chromosomes in every organism is fixed

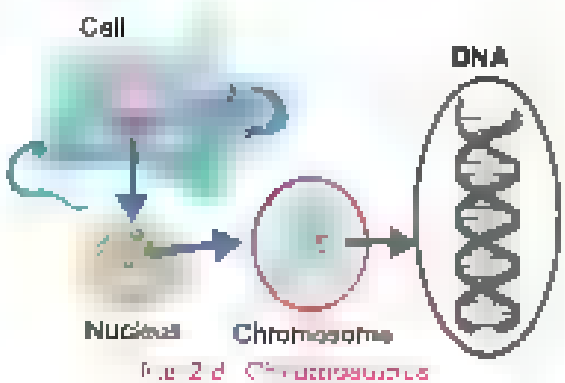


Fig 2.8 Chromosomes

Deoxyribonucleic Acid (DNA)

Chemically a chromosome consists of proteins and nucleic acid A molecule of DNA consists of two strands linked with each other by braids like a ladder twisted around each other DNA is a very large molecule and consists of units called nucleotide A nucleotide consists of phosphate sugar and base There are four types of bases. Adenine Guanine Thymine and Cytosine Every living thing has its own distinct DNA DNA stores genetic information in the sequence of its nucleotide

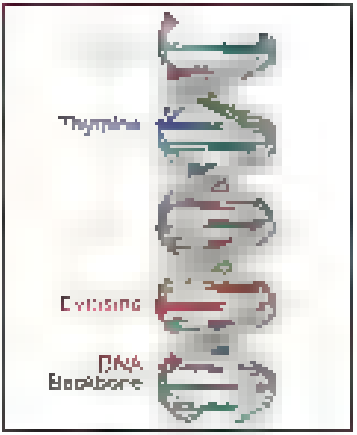


Fig 2.9 DNA

HEREDITY

- Define heredity and recognize its importance in transferring of characteristics from parents to offsprings.

Have you ever come across a comment that you look exactly like your mother or your hair is curly like your father, how is it possible?

All living things during reproduction pass on their characteristics to their offspring. This is the reason that you may resemble to your

mother or father in some way. Similarly, plants grown from seeds resemble to their parent plants. This transmission of characteristics from parent to offspring is known as inheritance process (Heredity). The characteristics such as eye colour, texture and colour of hair, skin colour, attached or free earlobes are some of the heredity characteristics that pass on from parents to their younger ones.

Activity 2.3.

Exploring Hereditary Characteristics of Family Members

Closely observe some of the physical characteristics mentioned in the table with the members in your family and try to record your observation in the table given below.

Eye colour							
Height							
Texture of hair							
Complexion							

Based on the data in the above table, discuss answers of the following questions with classmates.

- Which physical trait is commonly found in your family?
- Which physical trait was found with your grandparents?
- Did you notice any physical trait which is not found in your brothers or sisters but is found in yourself?

TRANSMISSION OF CHARACTERISTICS

- Identify the characteristics that can be transferred from parent to offsprings

As you have already studied about chromosomes and genes, so let us see how different characteristics are and traits pass on to offspring by parents. As you know when organisms produce gamete as part of meiosis, the number of chromosomes is reduced to half, meaning that the DNA has been reduced to half in the gamete cells. The male cell is haploid and egg cell is haploid will fuse to form a diploid zygote cell called zygote. This zygote is the first cell of an organism from which the new life of an organism begins. In the zygote the complete heredity material is restored and the new offspring will have some genes from female parent and some genes from the male parent resulting in a offspring with a different genetic make up.

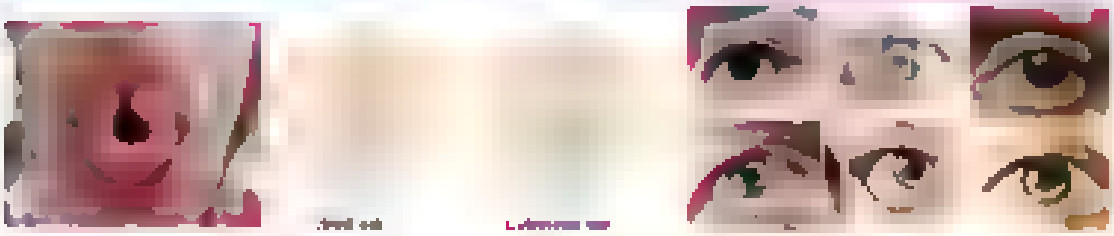
Inheritable and Non-inheritable Characteristics

Although we are now aware of the phenomenon of genetics, it was a matter of mystery for centuries. How the characteristics are inherited from parents to offsprings? How do we explain the presence or absence of some other characteristics in offspring? These and similar other questions were commonly asked by the inquisitive people of the millennium with no definitive answers.

Gregory Mendel was a pioneer among geneticists who put forward the concept of inheritance of characteristics or traits from parents to offsprings.

EXAMPLES OF INHERITABLE CHARACTERISTICS

- Compare characteristics related to ear and eye colour



Rolling of tongue | Attached and free earlobe | Colour of eye

Fig 2.10: Inheritable Characteristics

Activity 2.3 Comparing characteristics related to ear and eye colour among your classmates

Student #	Characteristics	Inherited from			
	Lobed Ear	Father	Mother	Maternal Grandparents	Paternal grandparents
	Lobeless Ear				
	Black Eyes				
	Blue Eyes				
	Green Eyes				
	Brown Eyes				

Activity 2.4 Survey your class to observe and find the other types of inherited characteristics among your classmates

Characteristic	Number of class-fellows
Curly Hair	
Straight Hair	
Ear lobe attached	
Ear lobe free	
Can roll tongue	
Cannot roll tongue	
Fair coloured skin	
Dark coloured skin	
Eye colour	
Hair colour	
Smooth chin	
Cleft chin	

SUMMARY

- DNA, deoxyribonucleic acid resembles a long spiral ladder
- There are two methods of cell division i.e Mitosis and Meiosis
- In Mitosis separation of chromosomes into two identical sets of daughter cells occur
- Somatic or body cells divide by Mitosis for growth, repairing and development
- Meiotic cell division is also called as reduction division in which the number of chromosomes are reduced to half during reproduction.
- Sex cells are divided by Meiosis for reproduction
- The process through which characteristics are transferred from parents to the offspring is called inheritance
- Children resemble to their parents because they inherit many characteristics from them

EXERCISE

Q1 Write short answers of the following questions

Explain the system in Mitosis cell division

(b) What is the purpose of Meiosis?

What is the purpose of Interphase?

What does diploid and haploid mean?

(c) Define following terms

1 Homologous chromosomes 2 Genes 3 Cytokinesis

Name two types of cell division and their purpose

(e) Differentiate between Mitosis and Meiosis

Define heredity and give some examples of hereditary characteristics

Define DNA and draw its diagram

Q2. Fill in the blanks with suitable words.

Characteristics like attached ear lobes and tongue rolling are _____ from parents.

(iii) Chromosomes contain

The cell divides by two methods 1 _____ and 2 _____.

(iv) Prophase means _____

Passing on of characteristics or traits from parents to off springs is called _____

Q 3 Project Mitosis Flip Book

Instructions. Complete each page to illustrate the changes that take place in a cell during cell division. The first oval (or ovals) in each phase should show the location of the organelles at that stage. Use the extra ovals to show the movement of organelles between stages. Once you have completed all the diagrams organize this book by stapling different pages in sequence. Flip through your book to view cell division

Changes during cell division

Mitosis Flip Book
by

Interphase

Prophase

Metaphase

Anaphase

Telophase

Cytokinesis

CHAPTER 3

BIOTECHNOLOGY

In the previous chapter, you studied in detail how nucleus of living cell is packed with different codes and information necessary for the life processes. Scientists studied briefly DNA because the life growth and unique features of an organism depend on its DNA. Scientists used several laboratory techniques to change the DNA of living organisms to produce desired qualities and characteristics resulted in the improved living standard for human being. The branch of science which deals with the use of microorganisms animal cells plant cells or their components to produce useful products for humans is called **BIOTECHNOLOGY**

In this Chapter you will learn about:

- Biotechnology
- DNA Replication
- Introduction to Gene Sequencing
- Genetic Modifications (Microorganism Resistance, improved Nutrition and Quality of Food
  Biotechnology Product Saving Lives (Insulin Vaccines)
- General Applications (Agriculture, Environment, Health, Food Production and preservation

All the students will be able to

- Define biotechnology
- Explain how DNA is copied and made
- Describe the relationship between DNA, genes and chromosomes
- Define bacterium
- Explain how genes are introduced into a bacterium
- List some biotechnological products used in daily life
- Explain that genetic modification in different foods can increase the amount of essential nutrients.
- List general application of biotechnology in various fields
- Explain how biotechnology allows meeting the nutritional needs of growing populations

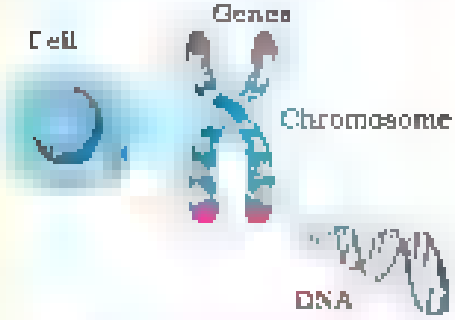


Fig 3.1 Gene, DNA, Chromosomes

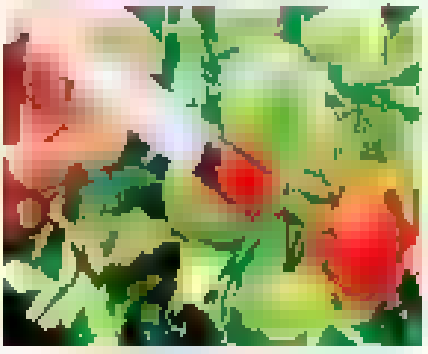


Fig 3.2 Applications of Biotechnology in Food Industry

BIOTECHNOLOGY

- Define Biotechnology

The word **biotechnology** is derived from two words, bio and technology. Bio means life and technology means scientific methods to create new products and solutions. Biotechnology is handling of living organisms or their components to perform practical task or to produce useful products.

Fig 3.1 Biotechnology is crop improvement, drug production, gene therapy

Humans have practiced it to solve problems of food shortage and improve their way of life for several centuries. In past it was used to make alcohol and cheese by microorganisms, to do selective breeding. Selective breeding is a process used to develop new organisms with desirable characteristics of life stock and field crops, to produce antibiotics from microorganisms and to synthesize antibodies.

Now a days modern techniques have allowed us to manipulate genetic material of living organisms to develop a wide range of new products and improve the nutritional values of food products. Biotechnology is now playing a very important role in the diagnosis of infections as well as genetic disease. To understand biotechnology, let us first explore how the genetic material Deoxyribonucleic acid (DNA) replicates.

DNA REPLICATION

- Explain how DNA is copied and made
- Describe the relationship between DNA, genes and chromosomes

In the previous chapters you have studied that DNA is the hereditary material. It is a very complex molecule. The units of this molecule are called nucleotides. Each nucleotide itself is made up of three components. They are,

(i) Deoxyribose Sugar

(ii) Phosphoric acid

(iii) Organic basis

The information in DNA is stored in the form of code made up of four organic bases, Adenine (A), Guanine (G), Cytosine (C) and Thymine (T). Before cell division, the DNA material must be duplicated so that after all division, each new cell contains the full amount of DNA material. The process of making copies of DNA molecules within the cell nucleus is called DNA replication.

In 1953, James Watson and Francis Crick proposed the molecular model of DNA, which suggests the basic mechanism of DNA replication.

DNA Replication Process

DNA replication is the biological process of producing two identical copies of DNA from one original DNA molecule. This process occurs in all living organisms and is the basis for biological inheritance.

DNA is made up of a double helix of two complementary strands. During replication, these strands are separated. Each strand of the original DNA molecule then serves as a template for the production of its counterpart, a process referred to as semiconservative replication. As a result, the new helix will be composed of an original DNA strand as well as a newly synthesized strand.

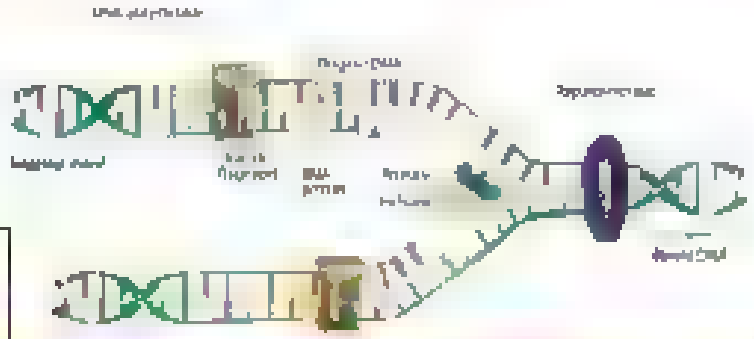


Fig. 4 : DNA Replication

Note: Teacher should [illegible] facilitate students watching the video on DNA structure from the link

Genes, Chromosomes and DNA

As you know that DNA is the hereditary material present inside the nucleus of all cells. Each strand of DNA is called chromosomes. Gene is a short sequence of nucleotides forming part of a chromosome. It is a unit of heredity which is transferred from a parent to offspring and to determine some characteristic of the offspring.

Fig.3.5 Gene, Chromosome and DNA

INTRODUCTION OF GENE INTO BACTERIUM

- Define bacterium.
- Explain how genes are introduced into a bacterium

Bacteria are considered as the smallest and simplest living organisms. The bacteria cell does not have an organized nucleus. The DNA is found floating in the cytoplasm with other cell organelles. This single large circular strand of DNA is containing most of the genes needed for cell growth, survival and reproduction. This chromosomal DNA tends to look like a mess of string in the middle of the cell. In addition to a single large piece of chromosomal DNA, cells also contain small pieces of DNA called plasmids. These plasmids, circular rings of DNA, are replicated independent of the chromosome.

Genetic engineering usually utilizes bacterial cells and their plasmids. To get a desired set of genes, scientists select and isolate the genes from one organism and insert it into the DNA of other organism which in this case is bacteria. For example, human insulin is made by isolating the gene of human insulin and then inserting this gene into the DNA of bacteria. These bacteria multiply, the new cells will contain the copies of the "engineered" plasmid. The foreign gene directs the cell to produce the human protein insulin.

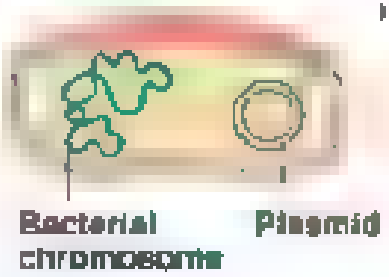


Fig. 3.6 A Bacterium

GENETIC MODIFICATION

- Explain how genetic modification in different foods can increase the amounts of essential nutrients
- Explain how biotechnology allows meeting the nutritional needs of growing populations

Scientists concerned with feeding the growing human population are using DNA technology to improve the productivity of plants and animals important to agriculture. The scientists in agriculture field have already provided several crop plants with genes of desirable qualities. Biotechnology has played a revolutionary role in improving our agriculture and production of high yields of crops. Cultivation of such genetically modified crops improves the quality of crops and makes them safe for human consumption. The major crops that have been modified are maize, wheat, rice, canola, potato, soya bean, cotton etc.

DO YOU KNOW?

In many poor countries where main food of people is rice, in such countries population faces an issue of malnourishment and deficiency of various key nutrients. One of the nutrients is Vitamin A, whose deficiency may cause early blindness and weak immune system among children. Some of Vitamin A is reserved through biotechnology in the plant of rice by genetic engineering of rice variety.

BIOTECHNOLOGY PRODUCT SAVING LIVES (INSULIN, VACCINES)

- List some biotechnological products used in daily life

Production of **Human insulin** is a great achievement of medical sciences. The human gene that secreted insulin is isolated from the pancreatic cell. The gene is inserted into the plasmid of bacterium. The recombinant bacteria with insulin gene are reproduced and the desired protein (insulin) is produced for commercial purpose. Similarly, Vaccines are the substances which contain the disease producing pathogens in the weakened form. When these vaccines are inserted into human body then the white blood cell produce special type of proteins (antibodies)

against these foreign particles to attain immunity against that disease. Scientists now use microorganisms to synthesize the desired vaccines. They identify the proteins of these diseases causing microorganism. These proteins when inserted in human body do not cause disease but stimulate the defense mechanism by producing the antibodies against that disease. This way certain life-threatening diseases such as Tuberculosis (TB), measles, typhoid, polio can be prevented when people are given the shots of these vaccines at an early stage.

DO YOU KNOW?

- Infants should be immunized with BCG vaccines against tuberculosis.
- MMR vaccines are given to children to develop resistance against measles.
- Typhoid vaccine is to be used against typhoid disease.
- Children can be immunized against polio disease with polio vaccine.

Activity 3.1:
Cut out news articles on outbreaks of disease in your country or other parts of the world. Find out what type of microorganisms, if any, cause this disease. How are these disease being treated or controlled? Are these treatments and controls effective? Discuss the articles in class.

GENERAL APPLICATIONS (AGRICULTURE, ENVIRONMENT, HEALTH, FOOD PRODUCTION AND PRESERVATION)

➢ List general application of biotechnology in various fields.

Biotechnology has made a revolution in the field of medicine, agriculture, environment and industries. Some of its common applications in our daily life are,

- It allows mass production of protein which was difficult in past.
- The production of human growth hormone by bio-technology is used to treat dwarfism.

- Insulin produced by bio-technology is being used to treat diabetics
- Vaccines are made from treated bacteria or viruses
- Cotton, corn, potato and soya bean plants have been engineered to be resistant to either insects or herbicides
- It helps in enhancing the quality of crops like soya bean

DO YOU KNOW?

In Pakistan 80% of bananas are planted in lower Sindh. Sindh Agriculture University has introduced tissue culturing technique to increase the yield. The new variety of banana plant contains traits which delay quick ripening of fruit, thus helping in increased shelf life.

SUMMARY

- Biotechnology is the study of science that deals with the application of technology and materials on living organisms to derive a benefit in an ethical manner
- DNA is the heredity material
- Gene is the fundamental physical and functional unit of genetics
- Genetic engineering is the scientific process of changing the genetic coding of an organism by inserting and replacing a section of a gene with the new one
- Gene is basically responsible for producing certain kind of proteins which determines the physical and functional characteristics of an organism
- Bacteria is used in genetic engineering because of its ability to multiply in shortest span of time
- Gene replication is the process by which the DNA in a cell divides and replicates itself into two when cell division takes place
- Biotechnology is now applied in the field of medicine, agriculture, environment and industries
- Vaccines and insulin are everyday biotechnological products.

EXERCISE

Give short answer of the following

1. Define biotechnology

   Give some examples of achievements made in food and agriculture using biotechnology

2. Describe role of Bacteria in biotechnology

3. Write down some applications of biotechnology in daily life

Choose the best answers.

In which organism, the human insulin is inserted for the commercial preparation of insulin

a) Virus b) Bacteria

c) Algae d) Fungus

4. The production of human growth hormone is used for the treatment of

   a) Night blindness b) Dwarfism

   c) Osteomalayasia d) Diabetes

The process of making copies of DNA is called

a) Lengthening b) Regeneration

c) Repucation d) Reproduction

Name the vitamin whose gene is inserted in the rice plant creating a genetically modified rice variety

a) vitamin B b) vitamin K

c) vitamin A d) vitamin C

Which of the following disease can be treated by the use of vaccine

a) diabetes b) measles

c) AIDS d) cancer

6 The information in the DNA is stored in the form of code having _____ organic bases.

a) 4 b) 5 c) 6 d) 2

Small pieces of DNA are called

a) Plasmids b) replica c) Template d) Clone

8 The scientists who proposed the DNA model in 1953 were

a) Haber and Bosch. b) Schleiden and Schwann

c) Watson and Crick d) Darwin and Crick

Which of the following substances contains disease producing pathogens in the weakened form?

a) Antibodies b) Plasmids c) Vaccines. d) Antibiotics

Which of the following is not the organic bases of DNA?

a) Guanine. b) Thymine.

c) Adenine. d) Uracil

Match the column A and B

Column A	Column B
Tissue culturing technique	Double helix structure
Isolation of insulin	Structure of DNA
DNA	Copies
Cytosine and ribose sugar	Human pancreas
Replica	Increase of banana yield

CHAPTER 4

POLLUTANTS AND THEIR EFFECTS ON ENVIRONMENT

Have you ever heard about acid rain? Do you know humans are contributor to climate change and heat waves we face every year? Our direct and indirect activities, like deforestation and building homes and industries impact on the environment and the species that live in the vicinity. These human activities add certain substances in the environment which damages it, these are termed

In this Chapter you will learn about:

- Air pollutants (Sulphur dioxide, Carbon monoxide, Oxides of Nitrogen, Chlorofluorocarbons).
- Sources (Natural and From Human Activities)
- Harmful Effects (on Human Organ Systems: Lung Diseases, Brain Damage, Breathing, Headaches).
- Effects of Human Activity on Environment (Greenhouse Effect, Ozone Depletion and Global Warming, Acid Rain, Wild Life, Deforestation, Lack of Energy Resources).
- Saving the Earth (Solid Waste Management, Recycling of Materials, Conservation of Resources, Environmental Campaigns, Responsibility of All).

All the students will be able to

- Explain the various properties and harmful effects of air pollutants
- List problems in human organ system caused by air pollutants
- Plan and conduct a campaign that can help to reduce the air pollution in their local area
- Explain the greenhouse effect
- Describe the causes and effects of ozone depletion
- Carry out a research to explain global warming and its effects on life on earth
- Design a model to explain greenhouse effect
- Explain the formation of acid rain and identify its consequences on living and non-living things
- Define deforestation
- State the effects of deforestation on the environment
- Identify the human activities that have long term adverse effects on the environment
- Explain the importance of local and global conservation of natural resources
- Suggest ways in which individuals, organizations and government can help to make our earth a better place to live

Fig 4.1 Air Pollution

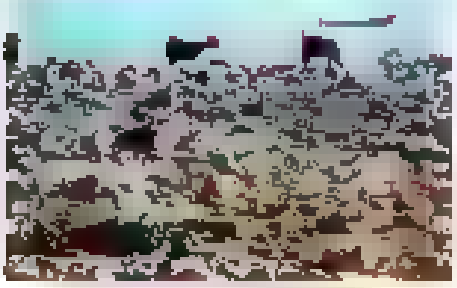


Fig 4.2 Global Warming

Fig 4.3 Deforestation

as pollutants. Let us explore different pollutants, their sources and effects on our environment, health and well being.

POLLUTANTS, THEIR SOURCES AND HARMFUL EFFECTS ON HUMAN ORGAN SYSTEMS

- Explain the sources, properties and harmful effects of air pollutants
- List problems in human organ system caused by air pollutants
- Plan and conduct a campaign that can help to reduce the air pollution in their local area

Conservation of quality of environment and its resources is the key to survival of our present and future generation. Unfortunately, human beings activities on earth are continuously altering the environment and making the survival of human race more difficult on this planet. Today human being is facing one of the most horrible ecological crises of his time i.e. pollution. Pollution is defined as the undesirable changes in the physical, chemical or biological characteristics of air, land and water that harmfully affect human life and other organisms.

Fig. 4.4 Sources of Air Pollution

Many substances can damage environment by making it dirty and unhealthy for the organisms living in the environment. The harmful substances which damage the environment are called pollutants and their introduction into the environment causes pollution. Air pollution is one of the most dangerous and common kind of environmental pollution that is being reported in most industrial cities of the World. It is caused when amount of solid wastes or concentration of gasses (other than Oxygen) increase in the air due to some natural processes or human activities. Some of the major air pollutants and their sources are mentioned below:

1. Sulfur Dioxide

Sulphur Dioxide a poisonous gas is one of the main by products of industrial and motor vehicle emission having a terribly irritating smell. Constant exposure to Sulphur dioxide can lead to a higher occurrence of cough, sneeze, and cold, shortness of breath, bronchitis, and fatigue. Air infected with Sulphur Dioxide is the main reason for asthmatic attacks. Eye irritation, eye watering, shortness of breath, lung damage are other common problems found in individuals.

Fig 4.5 Effects on Air Pollution

2. Carbon Monoxide

Incomplete combustion of fuel leads to exhaust of Carbon Monoxide. This colourless and odourless gas mostly results in disease related to heart like heart attacks, cardiovascular diseases among others as well as headache and reduced mental awareness. Carbon Monoxide in excess may affect the lungs and lead to weakening of lung functions. It may have drastic effect on cardiovascular organs and could lead to fatigue and low productivity in a healthy individual.

3. Oxides of Nitrogen

Nitrogen dioxide is one pollutant mostly found at major road junctions and in heavy industrial areas. It is also one of the main contributors of smog and has a adverse effect on the human health. Too much exposure to Nitrogen dioxide can lead to various respiratory and lung diseases, infections, lung irritation and respiratory symptoms for example cough, chest pain, difficulty in breathing.

4. Chlorofluorocarbon

Chlorofluorocarbons (CFC) a group of gasses which are widely used as refrigerants and industrial foaming agents. CFC is a major

cause of the depletion of ozone layer. Inhalation of high levels of chlorofluorocarbons can affect the lungs, central nervous system, heart, liver and kidneys. Symptoms of exposure to chlorofluorocarbons can include drowsiness, unclear speech, disorientation, tingling sensations and weakness in the limbs. Exposure to extremely high levels of chlorofluorocarbons can result in death. Ingestion of chlorofluorocarbons can also lead to nausea, irritation of the digestive tract and diarrhea.

Activity 4.1

Plan and Conduct a Campaign to Reduce Air Pollution in the Local Area

Design a flyer or chart paper with an information regarding the source and impact of major air pollutants on the human organ systems. Suggest some ways to reduce the air pollution in local area. Give presentations to students of other classes in your school. Also share this information with your family, neighbours, friends and relatives.

- Identify the human activities that have long adverse effects on the environment.

EFFECTS OF HUMAN ACTIVITIES ON ENVIRONMENT

A balanced relationship between living organisms, including humans and environment is essential to maintain life on earth. During last 100 years increased human population and wide spread industrialization societies have created a massive impact of human activities on the environment on earth. The unbalanced use of natural resources has created harmful impact on environment. For example, the change in our mode of transportation and heavy industrial wastes result in the emission of carbon dioxide and other industrial gasses responsible for

Teacher's Note

Teacher should facilitate students in preparing information material within their groups and should also plan how to disseminate this information with other members in the local area.

global warming which could lead to flood. The fungicides, insecticides used on crops ultimately reach in soil water and hence affect the soils environment and plant growth. These practices produce harmful effects on the environment as mentioned below

- Explain the formation of acid rain and identify its consequences on living and non-living

1. Acid Rain

Power stations and other industrial units run by burning of coal processes emit carbon dioxide, carbon monoxide, sulfur dioxide and Nitrogen oxide into the air which can dissolve in rain water to form acid rain. Acid rain affects the photosynthesis and growth of plants. When acid rain falls in rivers and lakes it can kill the aquatic organisms. Acid rain is not only a health hazard, but also can destroy many manmade structures, metals and statues of archaeological importance, kill many animals, destroy the agricultural land and cause damage to crop and plants.

Fig 1.6 Effects of Acid Rain

- Explain the greenhouse effect
- Carry out a research to explain global warming and its effects on life on earth
- Design a model to explain greenhouse effect

2 Greenhouse Effect or Global warming

Carbon dioxide gas is produced when trees and fossil fuels are burnt. Carbon dioxide is a major greenhouse gas as it trap the sun heat and prevents it from escaping into space, just like the way a greenhouse traps heat from the sun. As more trees are burnt more Carbon dioxide is released into the atmosphere

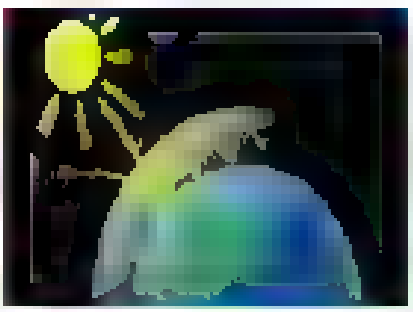


Fig 1.7 The Greenhouse Effect

and greenhouse effect increases. As a result the average temperature of the surface of the earth increases. This is known as global warming. Other gasses which contribute to the greenhouse effect are also being released in the atmosphere by human activities. These include methane, nitrous oxide and CFC (Chlorofluorocarbon).

Activity 4.2

Design a Model on Green House Effect

Things we need: Two glasses, cold water, ice cubes, plastic bag, thermometer

Steps: Fill two glasses of equal size each with 2 cups of cold water. Put five ice cubes in each glass, then wrap one in a plastic bag and seal it tightly. Place both glasses in the sun for one hour, then measure the water temperature in each glass using a household thermometer. What did you observe? The glass covered in plastic is warmer because the bag had trapped heat in the glass. In the same way, the greenhouse gases trap heat in the atmosphere.

➢ Describe the cause and effects of ozone depletion

3. Depletion of Ozone Layer

High up around the earth in its atmosphere, in between twelve to fifty kilometers above the ground, there is a layer of ozone gas (O_3). The Ozone protects the earth and the organisms from harmful effects of ultra violet rays of the sun. The release of chlorine atoms into the atmosphere break down the ozone shield. The major source of chlorine is Chlorofluorocarbon (CFC).

Fig. 4.8 Ozone layer surrounding the Earth

Due to the depletion of ozone layer, ultra violet light penetrates and reaches at the earth surface and causes skin cancer and many other lethal effects on many organisms including humans.

➢ Define deforestation
➢ State the effects of deforestation on the environment

4 Deforestation


Fig. 4.9 Deforestation

Forests are vital to our Earth. Trees purify our air, filter our water, prevent erosion, and act as a buffer against climate change. They offer a home to plant and animal species. While trees provide natural resources such as medicine, food, timber, and fuel. Deforestation can be defined as the permanent destruction of forests to make the land available for other uses. Major causes of deforestation include overpopulation, paper mining, logging, agriculture expansion and climate change. Some of the effects of deforestation on environment and human life are mentioned below,

1. Increased Greenhouse Gas Emissions

   Trees help to mitigate carbon dioxide and other greenhouse gas emissions, but they become carbon sources once they are cut, burned, or otherwise removed.

2. Acidic Oceans

   The oceans are becoming more acidic with an increased supply of carbon dioxide from deforestation and burning fossil fuels, putting ocean species and ecosystems at an extreme risk.

3. Loss of Species

   Giant pandas, rhinos, and the Asian elephant are just a few of hundreds of endangered species due to deforestation.

4. Climate Control

   Trees block sun rays during the day and holds in the heat at night. Removing trees from the forest leads to extreme temperature swings that are harmful to plants and animals.

5. Flooding and Erosion

   Without trees, erosion often occurs and sweeps away the

nearby rivers. Erosion also results in the contamination of water supply which greatly decrease the quality of our drinking water.

6 Life Quality Decrease

Millions of people in the world depend on forests for hunting, small scale agriculture and medicine. Common materials we use every day such as latex, cork, fruit, nuts, natural oils, and resins are found in the tropical forests. Deforestation disrupts the lives of millions of people and leads to migration.

- Explain the importance of local and global conservation of natural resources.
- Suggest ways in which individual, organisation and government can help to make our earth a better place to live.

SAVING THE EARTH

There is something called a balance in nature. As we continue to overuse natural resources, a serious imbalance has been caused. It is very important to conserve the natural resources which are essential for survival, for example trees, water, energy. Natural resources conservation can be done in several ways. Simply making people aware and setting an example for others to follow are the biggest steps at individual level. Further, we can reduce pollution and save our natural resources by taking following actions at individual, organization and government level.

1 Plantation, forestation and protecting the wildlife by banning on the products made from the skin and body of animals.

2 Use reusable and recycled material, for example paper bags in place of plastic bags.

3 Avoid the unnecessary use of energy, for example switching off light and fans while leaving the room. Using stair instead of lifts.

4 Use technology to develop materials, products and processes which are environment friendly.

5 Use filters or scrubbers on industrial chimneys to remove sulfur dioxide.

6 Less use of fertilizers and pesticides.

7 Reduce water wastage in our daily activities and reuse water wherever possible.

SUMMARY

- Undesirable changes in the physical, chemical or biological characteristics of air water and land is called Pollution.
- The harmful substances which damage the environment are called pollutants
- Acid rain greenhouse effect or global warming depletion of ozone layers are the consequences of pollution
- We can conserve the natural resources by adopting good practices and policies at individual, organization and government level.

EXERCISE

Answer the following questions.

What are major air pollutants their causes and effects on human body?

2 Define pollution

What is the role of ozone layer in conserving the environment?

4 What is greenhouse effect?

5 Write down different ways to reduce pollution

Choose the best answers:

The most dangerous type of pollution is.

a, Water pollution b) air pollution

c) Noise pollution d) Land pollution.

Name the major cause of depletion of ozone layer

a, Carbon dioxide. b) Sulphur dioxide.

c) Chlorofluorocarbon d) Oxygen.

3 Which gas is emitted by incomplete combustion of fuel

a) Carbon monoxide b) chlorofluorocarbon

c) Carbon dioxide d) Sulphur dioxide

The layer which protects the earth is called

a) Ozone. b) oxygen layer

c) CFC layer d) Green house.

5 Which gas from the following is mainly responsible for Green House effect in the environment?

a) Nitrogen dioxide b) Methane

c) Sulphur Dioxide d) Carbon Dioxide

The phenomenon which leads to destruction of manmade structure and metal of archaeological importance is

a) Floods b) Tsunami

c) Acid rain d) Green House

The step which can save the earth and natural resources

a) Wastage of water b. gas engines in the air

c) use recycled and reusable material d) deforestation

8. The animal included in the endangered species is

a) Deers. b) Giant pandas.

c) Jackals. d) Cat

9. The poisonous gas which is the main byproduct of motor vehicle with irritating smell is.

a) Oxygen. b) Sulphur Dioxide

c) Silver Nitrate d) Ammonia

10. The ozone layer is present in the atmosphere approximately

a) 5 to 10 Km high up the ground

b) 16 to 20 Km high up the ground

c) 12 to 50 Km high up the ground

d) 16 to 50 Km high up the ground

Match the column (A) and (B)

Column(A)	Column (B)
Protection of earth	Deforestation
Permanent destruction of trees	Save the earth
Less use of fertilizers	Exposure to CFC
Drowsiness and unclear speech	Pollution
Ecological crisis	Ozone Layer

CHAPTER

5 CHEMICAL REACTIONS

In previous classes we have learnt about atoms as the smallest particle of any matter. Also, elements as pure form of matter, and the way they interact with each other. Do you think that all these interactions always result into new compounds? No, we have already discussed that these interactions may result in either physical or chemical change. In this chapter, we will study the conditions necessary for any chemical change, types and nature of chemical reactions along with its significance in daily life. Let's explore on the basis of our prior knowledge. Do you think melting of ice is a chemical change? Have you observed fire as a result of burning coal in the presence of oxygen? Can you get back the paper which has been burnt? Why we inhale oxygen gas and exhale

In this Chapter you will learn about:

- Chemical Reactions (Definition & Applications)
- Chemical Equation and Balancing
- Law of Conservation of Mass
- Types of Chemical Reactions (Addition and Decomposition)
- Energy Changes in Chemical Reactions (Exothermic and Endothermic)

All the students will be able to:

- Define chemical reactions and give examples
- Explain the rearrangement of atoms in chemical reactions
- Explain the balancing of a chemical reaction
- Define the law of conservation of mass
- Identify the nature of a chemical change in various reactions
- Describe changes in the states of matter in a chemical reaction
- Explain the types of chemical reactions with examples
- Explain the energy changes in chemical reactions
- Describe the importance of exothermic reactions in daily life

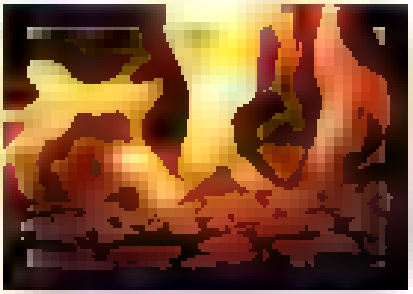


Fig 5.1 Combustion reaction

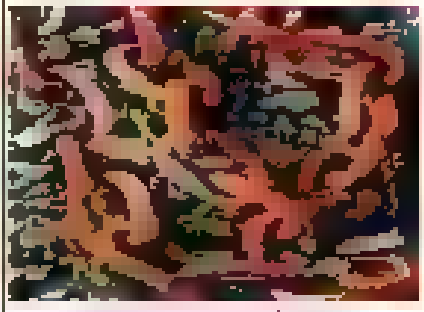


Fig 5.2 Rusted iron

carbon dioxide during respiration? Which of these interactions result in the formation of new compounds whose properties are different than the original compounds?

CHEMICAL REACTION

- Define chemical reactions and give examples
- Explain the rearrangement of atoms in chemical reactions
- Describe changes in the states of matter in a chemical reaction

Do you know what happens to coal when it is heated in the presence of oxygen? It results in the fire (heat) and evolution of gas like CO. Coal is black coloured solid form of carbon where as it produces CO_2 which is a colourless gas. This is an example of chemical change where product has different chemical composition and properties than the substance reacted. Also, the change is permanent and cannot be reversed. Hence, we can say that coal and oxygen reacted chemically to produce CO_2. Such process is called chemical reaction. Few more examples are,

Vinegar + Soda ——— Sodium bicarbonate

Iron nail + water ——— Rusting

Iron + Sulphur ——— Iron sulphide

Hence, we can say that

"A chemical change is called a chemical reaction"

The rearrangement of atoms takes place during chemical reactions. For example in the above case, an atom of carbon reacts with a molecule of oxygen to form a molecule of carbon dioxide with the evolution of heat. This is shown in the figure 5.3

Fig 5.3

Combustion of methane gas is shown in Fig 5.4. During this reaction, methane (CH_4) gas reacts with oxygen (O_2) gas to form carbon dioxide (CO_2) and water (H_2O). Rearrangement of atoms take place during this process. Carbon atom of methane (CH_4) gets attached with two oxygen atoms to form carbon dioxide, whereas two H atoms of methane get attached with oxygen atom to form water.

$$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$$

Methane molecule — Reactant
Two oxygen molecules — Reactant
Carbon dioxide molecule — Product
Two water molecules — Product

Fig 5.4

Chemical reactions are usually expressed in the form of chemical equation where the substances take part in the reaction are called reactants and are written on the left side of the arrow. Whereas the substances formed are called products and are written on the right side of the arrow. We can conclude that chemical reaction

- produces new substance which may differ in the properties than the original substance
- occurs with absorption or emission of energy mostly in the form of heat
- may be fast, moderate or slow

When writing chemical equations, chemists often indicate the physical states of reactants and products by using the abbreviations g, l, s and aq in parentheses to denote gas, liquid, solid and the aqueous (water) environment. States of matter changes during chemical reactions. For example

$$2H_2(g) + O_2(g) \longrightarrow 2H_2O(l)$$

$$2HgO(s) \xrightarrow{\text{Heat}} 2Hg(l) + O_2(g)$$

Activity 5. 1

Rearrangement of Atoms

By using any of the above two equations, express the rearrangement of atoms in a chemical reaction as shown in figure 5.3

Activity 5. 2.

Identification of Chemical Reactions

Identify which of the following are chemical reactions or physical change and justify your answer in the box given below

1. Burning of paper
2. Burning of candle
3. Baking of Cake

Applications of Chemical Reactions

> **DO YOU KNOW?**
> Chemical reactions do not only take place in laboratory, but they occur all around us

This book, our body or food everything is made of chemical matter. Most of the changes in our surroundings are due to chemical reactions. For example every time we cook, light a match stick, take a breath or consume an antacid to get relief from stomach acidity, we carry out chemical reactions. Knowing some chemistry can help us in making day to day decisions that affect our lives. Like mixing of two chemicals at home.

> **Exploration**
> Can you identify few changes in your surrounding which can be categorized as chemical reactions?

Chemical reactions can be beneficial or hazardous to our health environment or society in general. For example

Photosynthesis

Green plants prepare their food by the process of photosynthesis. In this chemical reaction leaves convert carbon dioxide and water into food in shape of glucose and oxygen. It is one of the most common everyday chemical reactions and also one of the most important since this is how plants produce food for themselves and for the animals who eat these plants. Also, in this reaction oxygen is produced.

$$\underset{\text{Carbon dioxide}}{6\,CO_2} + \underset{\text{Water}}{6\,H_2O} \xrightarrow{\text{Sunlight}} \underset{\text{Glucose}}{C_6H_{12}O_6} + \underset{\text{Oxygen}}{6\,O_2}$$

Ozone Layer Depletion

Ozone layer is a belt of naturally occurring gas Ozone (O_3) above the surface of earth and serves as a shield to protect our earth from the harmful ultraviolet rays from the Sun. However this layer is getting destroyed due to the chemical reaction with compounds like Chlorofluorocarbons (CFCs) that are released from industries and aerosols like body sprays, perfumes.

$$O_3 + O \xrightarrow{\text{Ultraviolet rays}} 2O_2$$

CHEMICAL EQUATIONS AND BALANCING

- Explain the balancing of a chemical reaction
- Balance simple chemical equations

As we have already discussed that chemical reactions are represented by chemical equations in which chemical symbols are used to denote different elements and compounds as reactants and products. This is time to discuss as how and why we balance chemical equations. Take an example of following equation

$$H_2 + O_2 \longrightarrow H_2O$$

In this equation it is represented that hydrogen gas and oxygen gas when react form water. However this expression is not complete because there are twice as many oxygen atoms on the left side of arrow as on the right side. According to law of conservation of mass (which we will discuss later), there must be the same number of each type of atom on both sides of the arrow that is, we must have as many atoms after the reaction ends as we did before it started. So we can balance this expression by placing an appropriate coefficient (2 in this case) in front of H and H_2O

$$2H_2 + O_2 \longrightarrow 2H_2O$$

This is to note that we balance a chemical equation by changing the coefficients never the subscripts. Changing the subscript would change the identity of the compound. There is no one formula that we can use for balancing the equations, rather we do it with trial and error method. We can follow the steps given below while balancing any chemical reaction

- Write down the formulas of reactants to the left of the arrow and the formulas of the products to the right of the arrow.
- Once you have correct formulas of the reactants and products, begin balancing the equation by trying suitable coefficients that will make the number of atoms of each element the same on both sides of the equation.

- First look for elements that appear only once on each side of the equation and with equal numbers of atoms on each side. The compounds containing these elements must have the same coefficients. Next look for elements that appear only once on each side of the equation but in unequal numbers of atoms. Balance these elements. Finally, balance elements that appear in two or more compounds on the same side of the equation.
- Check your equation to see that it has the same total number of each type of atom on both sides of the equation arrow.

Consider the reaction of iron with hydrochloric acid to produce iron chloride and hydrogen gas. First write reactants on the left and products on the right side.

$$Fe + HCl \longrightarrow FeCl_2 + H_2$$

We can see that all three elements (Fe, Cl and H) appear only once on each side of the equation, but only Fe appears in equal numbers of atoms on both sides. Therefore Fe and $FeCl_2$ must have the same coefficient which is 1. The next step is to balance either the number of Cl atoms or H atoms on both sides of equation (you can choose any). To balance Cl we place the coefficient 2 in front of HCl.

$$Fe + 2HCl \longrightarrow FeCl_2 + H_2$$

We see for final check that the number of atoms of each element in both the reactants and products are same, which means that the equation is balanced.

Elements	Reactants	Products
Fe	1	1
H	2	2
Cl	2	2

Activity 5.3

Balancing the Equations

Balance the following equations by rewriting these with appropriate coefficients in the space given below

A) $Zn + HCl \longrightarrow ZnCl_2 + H_2$

B) $ZnSO_4 + O_2 \longrightarrow ZnO + SO_2$

C) $CuO + NH_3 \longrightarrow Cu + H_2O + N_2$

D) $Cd + HCl \longrightarrow CdCl_2 + H_2$

Exploration

Do you know why balanced chemical equations are important to scientists?

LAW OF CONSERVATION OF MASS

- Define the law of conservation of mass

In 1789, a French chemist, Antoine Lavoisier, who is known as the father of modern chemistry, put forward the law called "law of conservation of mass". According to him

In a chemical reaction, the mass is neither created nor destroyed but it changes from one form to another form or in other words, mass of reactants and products remains constant.

For example consider the formation of water molecule. Two hydrogen molecules combine with one oxygen molecule to form two water molecules. Calculating the mass of both sides of

reactions (reactants and products) we will find these exactly same

$2H_2 + O_2 \longrightarrow 2HO$

$2(1+1) + (16+16) \quad 2(1+1+16)$

$2(2) + 32) \quad 2(18.$

$4 + 32 \quad 36$

$36 \quad 96$

DO YOU KNOW

Atomic mass of H=1, and O=16 Use these to verify the law of conservation of mass in balanced chemical equation

Activity 5 4

Proving Law of Conservation of Mass through Calculations

Calculate mass of reactants and products in the given reaction important to note that your equation needs to be balanced.

So first step is to check whether the given chemical equation is balanced or not

$CH_3COOH + NaHCO_3 \longrightarrow CH_3COONa + H_2O + CO_2$

$CH_3COOH + NaHCO_3 \quad CH_3COONa + H_2O + CO_2$

Atomic mass C = 12 H = 1 O = 16 Na = 23

TYPES OF CHEMICAL REACTIONS

- Identify the nature of chemical change in various reactions
- Explain the types of chemical reactions with examples

There are different types of chemical reactions based on what happens when reactants change into products Here we will discuss two basic types of chemical reactions i addition reactions and decomposition reactions

Addition Reactions

Those chemical reactions in which two or more reactants combine to form a product are called addition reactions These are also called as combination reactions or synthesis reactions because in these reactions two or more substances combine and synthesize one substance For example the reaction of sodium and chlorine

to form sodium chloride,

$2Na\,(s) + Cl_2\,(g) \longrightarrow 2NaCl\,(s)$

Sodium Chlorine Sodium chloride

and the burning of coal (carbon) to give carbon dioxide

$C\,(s) + O_2\,(g) \longrightarrow CO_2\,(g)$

Carbon oxygen carbon dioxide

Decomposition Reactions

Decomposition reactions are the opposite of addition reactions. In decomposition reactions a single compound breaks down into two or more simpler substances. For example, the decomposition of water into hydrogen and oxygen gases

$2H_2O\,(l) \longrightarrow 2H_2\,(g) + O_2\,(g)$

Water Hydrogen Oxygen

Another example is decomposition of hydrogen peroxide to form oxygen gas and water,

$2H_2O_2\,(l) \longrightarrow 2H_2O\,(l) + O_2\,(g)$

Hydrogen peroxide water oxygen

Decomposition reactions happen spontaneously in unstable compounds, however, require external conditions like heat, catalyst or electric current to decompose the stable compounds.

Activity # 5.5: Addition or Decomposition Reactions

Identify which of the following reactions are addition reactions or decomposition reactions. Write your answer in the column next to each equation.

Chemical Reactions	Type of Reactions
$2Mg + O_2 \longrightarrow 2MgO$	
$2KClO_3 \longrightarrow 2KCl + 3O_2$	
$N_2 + 3H_2 \longrightarrow 2NH_3$	
$H_2 + Cl_2 \longrightarrow 2HCl$	
$CaO + CO_2 \longrightarrow CaCO_3$	
$CaCO_3 \longrightarrow CaO + CO_2$	

ENERGY CHANGES IN CHEMICAL REACTIONS (EXOTHERMIC AND ENDOTHERMIC)

- Explain the energy changes in chemical reactions
- Describe the importance of exothermic reactions

Almost all chemical reactions absorb or release energy. Heat is the form of energy most commonly absorbed or released in chemical reactions. The study of heat changes in chemical reactions is called "thermochemistry". Based on the changes in the heat content in reactants and products, we have categorized chemical reactions into two types.

Endothermic Reactions

Endothermic reactions are those reactions in which heat energy is absorbed or added to the system. "Endo" means inside whereas "therm" means heat. One common example is the decomposition of mercury oxide (HgO) at high temperature.

$$2HgO(s) \xrightarrow{Heat} 2Hg(l) + O_2(g)$$

Exothermic Reactions

Exothermic reactions are those reactions which release or give off heat. "Exo" means outside whereas "therm" means heat. One common example is combustion of hydrogen gas in oxygen which releases considerable quantities of heat energy.

Fig 5.5 Exothermic Reaction

$$2H_2(g) + O_2(g) \longrightarrow 2H_2O(l) + \text{Heat energy}$$

Exothermic reactions are very common and are significantly important in everyday life. When we take food, it gives out energy for the cells to function and to make proteins and new cells and hence our body grows. Without the exothermic reaction, every living cell would die due to the unavailability of energy.

Similarly exothermic reactions can be used for everyday purposes For example, thermite reaction which involves converting iron oxide to iron by reacting it with aluminium oxide This reaction is most commonly used to repair cracks in railway lines

Activity 5.6

Exothermic & Endothermic Reaction

Materials needed: clear glass or cup vinegar baking soda thermometer water common salt

Steps:

1. Put half the cup with vinegar (liquid).
2. Put thermometer to measure the temperature of liquid Record it below
3. Add a tablespoon of baking soda Stir and wait for a minute and then record the final temperature of a substance
4. Record the result of experiment 1
5. Wash the apparatus with water and repeat the same experiment with water (as liquid) and common salt
6. Record your result of experiment 2

Experiment 1 Vinegar and Baking soda

Initial Temperature °C

Final Temperature °C

Difference Final temperature initial temperature = °C

Experiment 2: Water and Common salt

Initial Temperature °C

Final Temperature °C

Difference Final temperature initial temperature = °C

Question

Comparing the initial and final temperatures what do you think is the type of both reactions? Why?

DO YOU KNOW?

Combustion neutralization and respiration are few examples of exothermic reactions Can we imagine life on this earth without these reactions?

Exploration: Why do you require more food for working?

our body is an exothermic engine It is how we maintain our body temperature at 98.6°F when the surrounding environment is only 60°F Can you think where this energy in our body comes from? Why do we feel hungry more in cold season?

SUMMARY

- In a physical change the shape, size, appearance or state of a substance may alter, temporarily. It is usually reversible and no new substance is formed
- In a chemical change, new substances are formed and energy changes are involved. There is a permanent change takes place in chemical reaction
- Chemical reactions take place all around us. few unstable substances react spontaneously whereas others require heat, light or catalysts to initiate the reactions
- The chemical formula of a substance is the symbolic representation of the actual number of atoms present in one molecule of that substance
- A complete chemical equation represents the reactants, products and their physical states symbolically
- Equations must always be balanced. Equations are balanced by the trial and error method
- Total mass of the reactants and products will remain conserved during a chemical reaction. this statement is called law of conservation of mass
- Chemical reactions that proceed with the evolution of heat energy are called exothermic reactions
- Chemical reactions that proceed with the absorption of heat energy are called endothermic reactions
- Addition or combination or synthesis is a reaction in which a new single compound is formed by the union of two or more substances.
- In a decomposition reaction, a compound breaks down into two or more simple substances by the application of heat or electricity

EXERCISE

1. Define Chemical reactions. Also write its examples in daily life.
2. Write four conditions which show the occurrence of chemical reaction.
3. Which ones of the following are physical (P) or chemical (C) change
   a. Rusting of forks
   b. Melting of ice
   c. Change in taste of milk
   d. Digesting your food
   e. Change in meat's smell after it is out in the sun for some time
   f. Carving on a piece of wood
   g. Mixing of sugar in water
   h. Mashing potatoes
   i. Lighting a match
4. Balance the following equations
   $S_8 + O_2 \longrightarrow SO_2$
   $C_2H_6 + O_2 \longrightarrow CO_2 + H_2O$
   $P_4 + O_2 \longrightarrow P_2O_5$
   $Ag + S_8 \longrightarrow Ag_2S$
   $Al + Br_2 \longrightarrow AlBr_3$
   $Cr + O_2 \longrightarrow Cr_2O_3$
   $NaClO_3 \longrightarrow NaCl + O_2$
   $Al_2Br_4 + Cl_2 \longrightarrow AlCl_3 + Br_2$
5. Choose the correct answer
   a. What is an example of a synthesis reaction?
      A. CO_2 breaking down to $C + O_2$
      B. $Zn + 2HCl \longrightarrow ZnCl_2 + H_2$
      C. Hydrogen and Oxygen combining to form water

b Which is the BEST indication that a chemical reaction has taken place?

A Blue powder turns water blue

B A white substance dissolving in water

C Metal bubbling when placed in an unknown liquid

c What are the products in the reaction $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

A. Carbon Dioxide and Water

B Carbon Monoxide and Hydroxide

C Salt and Vinegar

d Which of the following is an example of a chemical reaction?

A salt crystals forming as sea water evaporates

B paper turning soft when wet

C leaves changing colours in the fall

6 Compare exothermic and endothermic reactions. Write down similarities and differences?

7 Write a note two examples of addition and decomposition reactions

8 Describe the importance of exothermic reactions

9 Write down the chemical reactions of the following in the form of balanced chemical equations

a Carbon dioxide (CO_2) and water (H_2O)

b Carbon monoxide (CO) and oxygen (O_2)

c Zinc (Zn) and hydrochloric acid (HCl)

d Hydrochloric acid (HCl) and sodium hydroxide ($NaOH$)

e Decomposition of potassium chlorate ($KClO_3$)

CHAPTER 6

ACIDS, ALKALIS AND SALTS

In previous classes we have learnt about the uses of different compounds in our daily life. We have also studied that a new compound is formed when two or more substances react together and change chemically. This means that compounds may have different physical and chemical properties. In this chapter, we will study the nature of compounds in the light of their behavior as acids, alkalis and salts. Do you know what stomach secretes from the lining of its wall to help in digestion? Have you ever suffered with the acidity in stomach? How did you cure it? Why some foods are sour whereas others are bitter in taste? Are these substances chemically same or different?

In this Chapter you will learn about:

- Introduction to Acids, Alkalis and Salts
- Properties of Acids, Alkalis and Salts
- Uses of Acids, Alkalis and Salts
- pH and its Range (1 - 14) in Aqueous Medium
- Indicators and their Uses: Natural indicators from Fruits and Vegetables

All the students will be able to

- Define the terms acid, alkali and salt
- Describe the properties of acids, alkalis and salts
- Explain the uses of acids, alkalis and salts in daily life
- Define indicators
- Use indicators to identify acids, alkalis and neutral substances
- Investigate the colour changes in the extracts of various flowers and vegetables by adding acids and alkalis

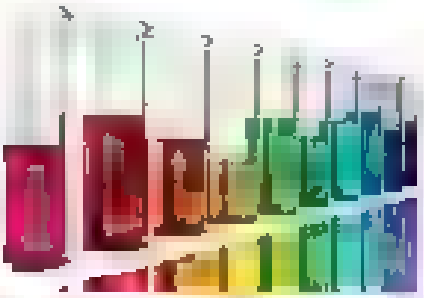


Fig. 6.1 Colours of different substances

Fig. 6.2 Acids and Alkalis around us

Exploration Farmers are suggested to get their soils tested before selecting and putting fertilizers. Why?

INTRODUCTION TO ACIDS, ALKALIS AND SALTS

- Define the terms: Acids, Alkalis and Salts

Do you know why vinegar and lemon juice are sour in taste? Nobody knew this until a few hundred years ago when it was discovered that these things are acids. The term acid, in fact, comes from the Latin term acere which means "sour". Initially acids and bases are defined as substances that change some properties of water. The concept evolved in 19th century when these substances were categorized based on their tastes. For example, acids are sour-tasting stuff.

Exploration
Have you eaten salads with vinegar? What is its taste? What do you think vinegar is?

With the passage of time, people found out that the sour-tasting stuff had some other properties in common, apart from just tasting sour. For example, it changes the colour of litmus paper and corrodes some metals. Lavoisier, the father of modern chemistry, gave a new idea about the chemistry of acids that there is some element, or essence in the acid that would be responsible for its acidity. In 1840s it was proposed that acidity was generated by hydrogen, because it is the component all acids have in common. Swedish chemist, August Arrhenius in 1903 defined acids and bases on their properties of ionization in the solution and received Nobel prize on his discovery. According to Arrhenius

Acids are those substances which produce hydrogen ion (H^+) in the aqueous solution.

For example, hydrochloric acid (HCl) is a common acid when dissolved in water, dissociates into H^+ and Cl^-. H^+ on combines with water to form hydronium ion (H_3O^+).

$$HCl + H_2O \rightarrow H_3O^+ + Cl^-$$

Whereas

Bases are those substances which produce hydroxyl ion (OH) in the aqueous solution.

For example sodium hydroxide (NaOH) is a common base which dissociates into Na^+ and OH^- when dissolved in water

$$NaOH \rightarrow Na^+ + OH^-$$

This is important to note that those bases which are soluble in water are termed as alkali. All acids have H^+ ion and bases have OH^- ions

DO YOU KNOW?

All alkalis are bases but all bases are not alkalis

Activity 6.1

Identification of Acidic and Basic Substances

Instructions: Identify which of the following formulae represent acidic or basic substance. Mark the checks in the correct column. Also, justify your response during discussion with your classmate sitting next to you.

Substance (Formulae)	Acids	Bases	Reasons
H_2SO_4			
KOH			
HCl			
CH_3COOH			
NH_4OH			
$Ca(OH)_2$			

Salt

When acid is mixed with base at certain point acidic nature of acid and basic nature of base are destroyed. The resulting solution is neither acidic nor basic but neutral. This process is called *neutralization* and that point is called *neutralization point*. If you touch the

DO YOU KNOW?

H_2O is the main product of neutralization as it is formed by the H^+ from acid and OH^- from base

test tube immediately after neutralization point you will feel test tube hot as heat always released during neutralization reaction and hence increase the temperature of reacting mixture A new substance formed as a result of neutralization is called "salt" along with H_2O

$$HCl + NaOH \leftrightarrow H_2O + NaCl$$

Activity 6.2

Match with the Correct Option.

Instructions Identify which of the acid base pair mentioned in column B will neutralize to form the following salts in column A Write your answers in the space given below

	Salts		Acid & Base
1	Sodium Benzoate (C_6H_5COONa)	a	Potassium hydroxide (KOH) and Hydrochloric Acid (H_2)
2	Potassium Chloride (KCl)	b	Sodium hydroxide (NaOH) and Nitric Acid (HNO_3)
3	Sodium Acetate (CH_3COONa)	c	Sodium hydroxide (NaOH) and Acetic Acid (CH_3COOH)
4	Sodium Chloride (NaCl)	d	Sodium hydroxide (NaOH) and Benzoic Acid (C_6H_5COOH)
5	Sodium Sulphate (Na_2SO_4)	e	Sodium hydroxide (NaOH) and Hydrochloric Acid (HCl)

Answers: 1 2 3 4 5

PROPERTIES OF ACIDS, ALKALIS AND SALTS

- Describe the properties of acids, alkalis and salts.

Acids are sour in taste as you have studied that vinegar and lemon are sour in taste Whereas Bases are bitter

There are many acids and bases which occur in nature. Several acids and bases are also prepared. Few examples are mentioned below

Name of Acid	Found in
Tartaric Acid	Tamarind, grapes
Citric Acids	Citrus fruits like lemons and oranges
Lactice Acid	Yogurt
Ascorbic acid	Amla, Citrus Fruits

Name of Base	Found in
Calcium hydroxide	Lime water
Sodium hydroxide potassium hydroxide	Soap
Ammonium hydroxide	Window cleaner
Magnesium	Milk of Magnesia

Similarly, there are naturally occurring salts which are processed from salt mines or by the evaporation of sea water. Several soluble and insoluble salts can be prepared in the laboratory through neutralization process

Activity 6.3:

What is What

Instructions: Using the above information, taste the following food items, write whether these are sour, bitter or of any other taste and predict their acidic or basic nature.

Precautions: Don't taste things unless it is asked to do so. Every acidic and alkaline substances around us are not safe to taste and touch

Food Item	Sour / Bitter / Saltish	Acidic / Basic / Salt
Yogurt		
Common salt		
Lemon juice		
Baking Soda		
Tamarind (Imli)		

Electric Conductivity: We all know that water is a bad conductor of electricity. But the tap water contains charged particles like magnesium and calcium ions due to the presence of salts into it. Hence it is dangerous to use electrical appliances if the surface area is wet.

Activity 6.4

Electrical Conductivity

Note for Teachers: Arrange the materials at local site

Materials required: Two nails, cork, beakers, 6 volt battery (electricity source), bulb, switch, 10 ml of each of the following.

1.0 M HCl, 1.0 M NaOH, distilled water, tap water, NaCl solution, vinegar, sugar and water solution, NaCl solid.

Procedure:

1. Fix two nails on the cork and place the cork in the beaker as shown in the figure 6.3
2. Connect the nails to the two terminals of 6V battery through a bulb and switch
3. Pour some HCl in the beaker and switch on the current
4. Record your observation in the fosowing grid
5. Repeat the experiment separately with other substances
6. What do you observe? Does the bulb glow in all cases?

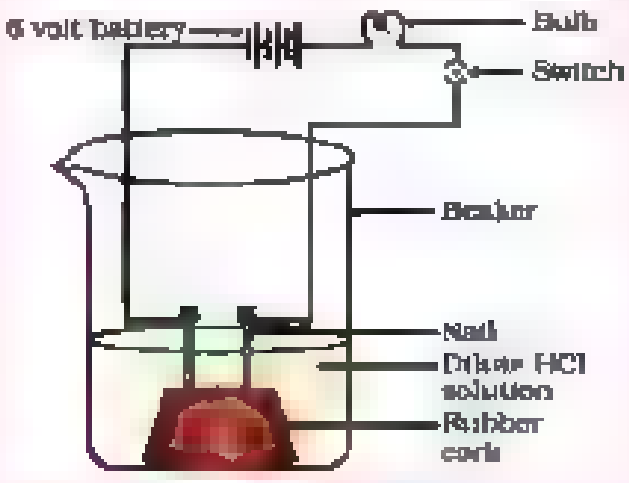


Fig. 6.3

Observation.

Substances	Intensity of Light Bulb (very bright, bright, dim)	Conducts Electricity? (yes / no)
HCl NaOH		
Distilled water		
Tap water		
Vinegar		
NaCl solid		

Based on your above observations this is now clear that acids and alkalis are good conductor of electricity. Similarly salts also conduct electricity in molten and solution form but not in a solid state

Exploration

Can you discuss in your groups

- Why did the bulb glow in the solution of HCl and NaOH but not in sugar and water solution?
- Why did the bulb glow brighly in the HCl than the vinegar?
- Why did the bulb glow in the solution of NaCl and not in the solid form?

Litmus Test If the blue litmus paper turns into red or red litmus remain unaffected. then the substance is acidic in nature Whereas if red litmus paper turns into blue or blue litmus remains unaffected the substance is basic in nature. If neither the

DO YOU KNOW?

Predictions and observations are two important scientific skills

red litmus paper nor the blue paper changes its colour then the substance is neutral

Activity 6.5

Acid or Base

Material required: Test tubes, NaCl solution, blue and red litmus paper strips, shampoo, vinegar, lemon juice, tooth paste

Procedure:

1. Take three liquids in the three different test tubes
2. Before experiment, predict what would happen if the blue and red litmus papers are dipped in the given liquids placed separately in three test tubes
3. Register your prediction in the column below
4. Now perform the experiment and dip blue and red litmus paper strips in the three test tubes containing different liquids

Liquids	Predictions	Observations
NaCl		
Shampoo		
Vinegar		
Tooth paste		
Lemon juice		

USES OF ACIDS, ALKALIS AND SALTS

➢ Explain the uses of acids, alkalis and salts in daily life

Do you know that your stomach produces hydrochloric acid to help in digestion of proteins, kills harmful bacteria and minimizes the risk of food poisoning. Certain digestive enzymes require low pH less than 2 to function properly. On the other hand pancreatic fluids are alkaline, as

enzymes in intestine requires alkaline pH for breaking down starches fats and proteins. Further the uses of acids and alkalis are very common in industries and homes.

Following table shows uses of some common acids and alkalis

Acid		Base	
Example	**Uses**	**Example**	**Uses**
Benzoic acid	Its salt is used to preserve food	Ammonia	Production of fertilizers. Used in the manufacture of nitric acid
Carbonic acid	To make carbonated drinks	Aluminum hydroxide	Manufacture other aluminum compound and to make gastric medicine (antacid)
Acetic Acid	Main compound of vinegar	Calcium hydroxide	To make cement, limewater, neutralize the acidity of soil and application of sewage treatment
Hydrochloric acid	Household cleaning, leather processing	Sodium hydroxide	Used in the manufacturing of soaps, detergents and cleaners.
Nitric acid	Production of fertilizers, explosives, purification and extraction of gold	Magnesium hydroxide	Suspension of magnesium hydroxide in water is used as an antacid

Salt is essential for life in general, and saltiness is one of the basic human tastes. The animal tissues contain larger quantities of salt than plant tissues. Salts can be used in water conditioning, food agriculture and preparation of industrial chemicals ranging from plastic, paper, glass, polyester, rubber and fertilizers to household bleach, soaps, detergents and dyes.

Exploration

The sting of an ant contains formic acid. When an ant bite, it injects the acidic liquid into the skin. The effect of the sting can be neutralized by rubbing basic salts for example moist baking soda or calamine solution which contains zinc carbonate. Are all salts neutral or basic in nature?

pH AND ITS RANGE IN AQUEOUS MEDIUM

- Explain pH range for acids, and bases

The **pH scale** is a measure of the acidity or alkalinity of a solution. The pH of a solution, determines how acidic or alkaline it is by reference to the pH scale (Fig 6.4) or whether the solution is neutral. pH scale ranges between 1-14. The smaller the pH number, the more acidic it is, the greater the pH number, the more alkaline it is, and if the pH is close to 7, the solution is more or less neutral.

Note: Check the following substances with litmus paper to get an idea which of the following substances are acidic or alkaline.

1	2	3	4	5	6	7	8	9	10	11	12	13	14
Hydrochloric acid	Lemon juice	Vinegar	Soda	Rain water	Milk	Pure water	Egg white	Baking Soda	Milk of Magnesia	Ammonia	Mineral lime	Bleach	Sodium hydroxide

Fig 6.4

INDICATORS AND THEIR USES

- Define indicators
- Use indicators to identify acids, alkalis and neutral substances
- Investigate the colour changes in the extracts of various flowers and vegetables by adding acids and alkalis

An indicator is a dye substance or mixture of colored substances that when added to the solution gives a different colour depending on the pH of the solution. This helps to indicate whether the solution is acidic or alkaline. There are different chemicals or homemade indicators which are used to determine the pH value of any solution. The most accurate way of measuring pH is by using electronic pH meter

Common Chemical Indicators

Some common chemically prepared indicators are Phenolphthalein, Universal indicator methyl orange (Fig 6.5 & 6.6)

Phenolphthalein	Colourless	Pink
Bromophenol blue	Yellow	Blue
Methyl orange	Orange	Yellow

Fig 6.5 Methyl Orange

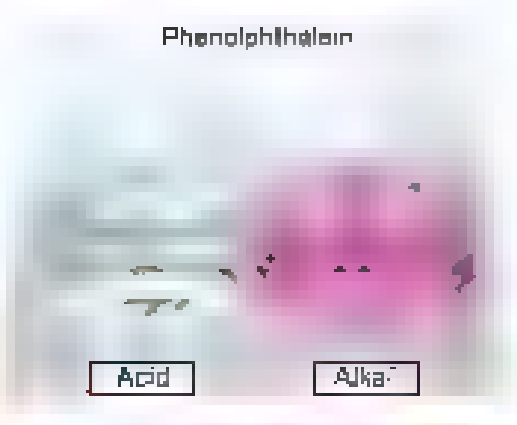


Fig 6.6 Phenolphthalein

Activity 6.6

Using Indicator(s) for Identification

Material used: HCl, NaOH, phenolphthalein, methyl orange, beet juice, beaker, glass dishes

Procedure

1. Take HCl, NaOH and NaCl (aqueous solution) in three beakers (don't label them as acid, base or neutral).
2. Mark the beakers as solution 1, 2 and 3.
3. Take small quantity of each in a different glass dishes separately and use the above indicators one by one in order to observe the colour change.
4. Record your observations in the given table.
5. Can you predict which solution is HCl (acid), NaOH (base) or NaCl (neutral).

Indicator(s)	Colour in solution 1	Colour in solution 2	Colour in solution 3
Phenolphthalein			
Methyl Orange			
Beet Juice			

SUMMARY

- Acidic substances generate H^+ ions in the medium while basic ones liberate OH^- ions in the medium
- Strength of an acid depends on the concentration of hydronium ions present in a solution. Greater the numbers of hydronium ions present, greater is the strength of the acid
- Strength of a base depends on the concentration of hydroxyl ions
- Those bases which dissolves in water are called alkali
- Salts are important compounds that are obtained by treating an acid with a base. Important salts used in everyday life and industrial applications are Sodium chloride ($NaCl$), Sodium carbonate (Na_2CO_3), Sodium Bicarbonate ($NaHCO_3$)
- Acidic and basic solutions are good conductors of electricity
- For acids, blue litmus paper turns into red whereas for bases red litmus paper turns into blue. Both litmus paper will remain unchanged in case if the solution is neutral
- The strength of an acid or base is expressed on a 14 point scale (ranges from 0 to 14) known as pH Scale
- An acidic solution has a pH less than 7 and a basic solution a pH more than 7, while a neutral solution has a pH of exactly 7

EXERCISE

The table shows the pH of four substances. Answer the questions below while considering the following table

Substance	pH
Blood	7.3
Orange juice	4
Ammonia	11
Milk	6.5

i) Which best describes milk?
a) Slightly basic
b) Strongly basic
c) Slightly acidic
d) Strongly acidic

ii) Which lists the substances from least to most acidic?
a) Ammonia, blood, milk, orange juice
b) Orange juice, milk, blood, ammonia
c) Ammonia, milk, blood, orange juice
d) Orange juice, blood, milk, ammonia

iii) Which substance is the most alkaline?
a) Blood
b) Orange juice
c) Ammonia
d) Milk

iv) Which substance has a pH value closest to neutral?
a) Milk
b) Blood
c) Ammonia
d) Orange juice

v) Which of the following would be most useful in testing if a substance is either an acid or a base?
a) Filter paper
b) Litmus paper
c) Thermometer
d) Electronic balance

CHAPTER 7

FORCE AND PRESSURE

Have you ever experienced pressing a pencil between your fingers?

What did you feel on the finger at the tail of pencil?

What did you feel on finger at the tip of the pencil?

On which side did you feel more pressure?

While you put same force on both sides why did you feel different effect on the fingers?

Can you repeat this activity with a new pencil before sharpening it?

Repeat the activity with a pencil sharpened on both sides

Feel the different effect of force and discuss the cause of effect in each case

In this Chapter you will learn about:

- Pressure, Force and Area
- Units (N m^{-2} and Pascal)
- Hydraulics and Hydraulic Systems
- Water Pressure
- Pneumatics (How Gases Behave under Pressure?).
- Gas Pressure in a Container
- Aerosols
- Atmospheric Pressure

All the students will be able to:

- Define the term Pressure
- Identify the units of Pressure
- Explain hydraulics and hydraulic system by giving examples
- Explain how gases behave under pressure
- Describe the causes of gas pressure in a container
- Explain the working of Aerosols
- Identify the application of gas pressure
- Describe the term atmospheric pressure

Fig 7.1 (a)

Fig 7.1 (b)

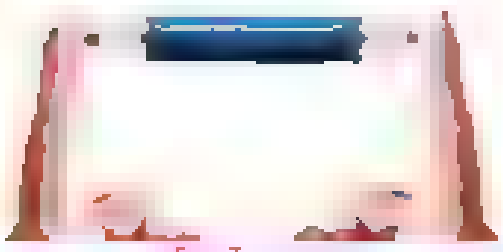


Fig 7.1 (c)

PRESSURE, FORCE AND AREA

▶ Define the term Pressure

Rani and Qaima visited Thar in summer vacation. One day they decided to go for walk on sand mounds. Rani put on her favourite high heel sandals, meanwhile Qaima put on her shoes with flat bottom.

As soon as they stepped out onto the sand, Rani's heels sink right through while Qaima has no trouble walking on sand in her flat bottom shoes. Why did this happen? If Rani and Qaima had almost the same weight and the same size, why did Rani fall through the sand while Qaima did not?

Fig. 3 Pressure acting on a surface

This occurred because even though both girls exerted the same force on the ground, Qaima's shoes spread that force over a larger area, causing the pressure on the ground to be much less.

Pressure describes how a force is spread over an area. It is a measure of force acting on a certain area. Pressure is calculated by the following formula,

$$\text{Pressure} = \frac{\text{Force}}{\text{Area}}$$

You can notice that the force is applied in a direction that is perpendicular to the surface of the object.

Pressure depends on two factors

1. Forces acting
2. Area of surface

Formula shows that larger the force, greater will be its pressure. Similarly, the smaller the surface area, greater will be the pressure.

Example 1:

A hammer is used to drive a nail into a wooden floor. The hammer is brought down with a force of **200 N**. The area of the top of the nail is **0.5 cm²**. What pressure is put upon the top of the nail by the hammer blow?

Fig 7.4

Solution.

Force = F = 200N

Area of nail = A = 0.5 cm²

Pressure = P = ?

$$\text{Pressure} = \frac{\text{Force}}{\text{Area}} = \frac{F}{A}$$

$$P = \frac{200N}{0.5cm^2} = \mathbf{400\ N/cm^2}$$

Example 2.

A truck has tyres of area 5 m². It puts a pressure of 15000 N/m² on the road. What is the weight of the truck?

Solution.

Given: Area = A = 5 m²

Pressure = P = 15000 N/ m²

Weight = W = F = ?

$$\text{Pressure} = \frac{\text{Force}}{\text{Area}} = \frac{F}{A} \quad \Rightarrow \quad F = W = P \times A = 15000 \times 5$$

W = 75000N

Activity 7.1

Effect of Area and Force on Pressure

Materials needed

Compression spring balance or electronic top-pan balance, metre ruler, lump of clay, piece of wood 20 cm x 1.5 cm x 1.5 cm, piece of wood 20 cm x 4.5 cm x 4.5 cm, pencil

Procedure:

- Place the lump of clay on the pan of balance as shown in the diagram below

- Take the piece of wood of cross-section 1.5 cm x 1.5 cm and push it down into the clay until the scale reads 40 N. Make a pencil mark on the wood to show how deep it has gone into the clay. Then remove the piece of wood.
- Measure how high the pencil mark is from the end of the piece of wood. This will tell you the depth of the dent in the clay.
- Repeat stages 2 and 3 above, but this time using the piece of wood of cross-section 4.5 cm x 4.5 cm. Push it down into a new area of the clay.
- Record your measurements in the table below.

Cross section of Wood	Depth of the dent (cm)	Force, F (N)	Area, A (cm^2)	Pressure, P = Force/ Area (N/cm^2)
1.5 cm x 1.5 cm				
4.5 cm x 4.5 cm				

a) Which piece of wood has made the deeper dent?

b) Which piece of wood has exerted the greater pressure?

c) Why the same force has exerted a different pressure on the clay?

d) Assume the two pieces of wood as the heels of shoes, which would cause the most damage to a floor?

UNITS OF PRESSURE

- Identify the units of Pressure

In Pressure force is expressed in Newtons (N) and area is expressed in square meters (m^2). Therefore pressure is expressed in N/m^2, which is the SI unit for pressure. This unit is also called the **Pascal** (abbreviated Pa). As Pascal is a very small pressure, therefore pressure may also be expressed in the kilopascal (kPa), which equals 1000 Pascals. For example, the correct air pressure inside a bike tyre is usually about 200 kPa (30psi).

Blaise Pascal was a French Scientist whose discoveries about pressure in fluids led to pascal's law after his name.

The amount of pressure at your tap can depend on how much high the service reservoir or water tower is above your home, or on how much water other consumers are using. The height of your house can also affect water pressure. houses at the top of a hill may receive lower pressure than houses which are at the bottom of the hill. The amount of force per unit area that water exerts, say on the container in which it is or on a submerged object is called water pressure. The pressure of water that is not flowing depends on the depth. Pressure is the force that pushes water through pipes. Water pressure determines the flow of water from the tap.

Activity 7.2

Water pressure at Different Heights

Materials

A plastic bottle or other available container of water. Tool to drill at least three holes.

Activity Setup:

Make 3 holes (A, B and C) in the bottle in a vertical arrangement. Place the holes at different heights with at least 1 inch apart.

Procedure:

- Cover the holes with your fingers
- Fill the bottle with water and place the cap on the bottle
- Expose the holes and observe the water flow from each hole

Note: You can quantify the activity by using a ruler to measure the initial contact points of the water flow from each hole.

Questions:

1 Observe the flow of water through the holes. What are your initial observations?

2 What appears to happen to the flow over time?

3 Explain why there are variations in the length of the water discharge from each of the three holes.

HYDRAULICS AND HYDRAULIC SYSTEMS: PASCAL'S LAW

➢ Explain Hydraulics and Hydraulic System by giving examples

Pascal's law states that when a liquid is placed in a container, the pressure applied to the fluid by the container is equal throughout the container. This phenomenon is used for hydraulic devices.

Hydraulics.

Hydraulics is a branch of science that deals with practical applications of liquid in motion. The pressure in a liquid is transmitted equally in all directions, so a force exerted at one point on a liquid will be transmitted to other points in the liquid. This technology is called Hydraulics. You must have seen the water

pistols, car lifters and big cranes. All these objects are using power of moving fluid.

Activity 7.3.

Pressure Transmitted Equally in All Directions

Materials

1 balloon, water, needle or something to poke holes in balloon with.

Step:

Fill balloon with water.

Procedure:

- Tie off balloon so there is very little air trapped inside.
- Quickly poke several holes around the perimeter of the balloon and squeeze.
- Observe the flow of water through the holes in the balloon.

Questions.

1. What are your initial observations?

2. How would you describe the flow of water from hole? Explain your observations.

Hydraulic Systems

Pressure can be transmitted through liquids. In hydraulic systems, exerting a small force over a small cross-sectional area can lead to pressure being transmitted, creating a large force over a large cross-sectional area. This ability to multiply the magnitude of forces allows hydraulics to be used in many applications such as car-braking systems. Hydraulic systems are also found in

- lifting equipment example hydraulic jacks and swing chair lifts.

- lifting and excavating machinery such as diggers
- hydraulic presses which are used during the forging of metal parts
- wing flaps and some rudders on aircraft and boats

1 Car Braking System

Car braking system cause a relatively small force from the driver's foot to produce a greater force which acts equally on all four brake pads. In a car brake system the force from the driver's foot exerts pressure on the brake fluid in a small piston.

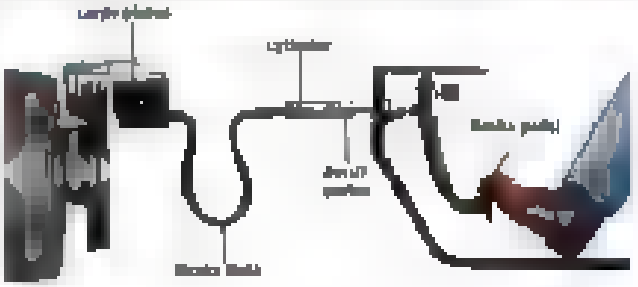
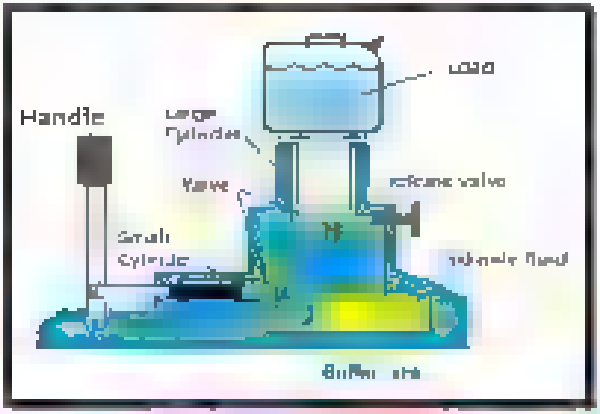


Fig. 7.6 Car Braking System

The brake fluid squirts down a long, thin pipe until it reaches another cylinder at the wheel which is much wider. When the fluid pushes the piston of greater cross section area, the transmitted pressure acts on this larger area to produce a larger load force on the brake pads. The pads then rub against the brake discs and cause the car to slow down.

2 Hydraulic Jack System

A hydraulic jack is a device used to lift heavy loads. The device itself is light, compact and portable, but capable of exerting great force. The device pushes liquid against a piston, pressure is built in the jack container. The jack is based on Pascal's law that the pressure of a liquid in a container is the same at all points.



How Hydraulic Jacks Work When the handle is pressed down, valve A is closed whereas valve B is opened. The hydraulic fluid is forced into the large cylinder and hence pushes the piston moving upward. When the handle is raised, valve B will be closed while valve A will be opened. Hydraulic fluid from the buffer tank will be sucked into the small cylinder. This process is repeated until the load is sufficiently lifted. The large piston can be lowered down by releasing the hydraulic fluid back to the buffer tank through the release valve. Essentially, if two cylinders (a large and a small one) are connected and force is applied to one cylinder, equal pressure is generated in both cylinders. However, because one cylinder has a larger area, the force the larger cylinder produces will be higher, although the pressure in the two cylinders will remain the same. Hydraulic jacks depend on this basic principle to lift heavy loads.

GAS PRESSURE IN A CONTAINER

- Describe the causes of gas pressure in a container

Gas pressure in a closed container is the result of the gas molecules hitting the inside wall of the container. The molecules move about and are attempting to escape the container. When they cannot escape, they strike the inside wall and then bounce around. The more molecules striking the inside wall of the container, the greater the pressure. This concept represents the kinetic theory of gases.

• Turning Up the Heat

Changing the temperature affects pressure in a closed container. Raise the temperature, and the pressure increases. This occurs due to the increased movement of the gas molecules. Double the temperature and you double the pressure.

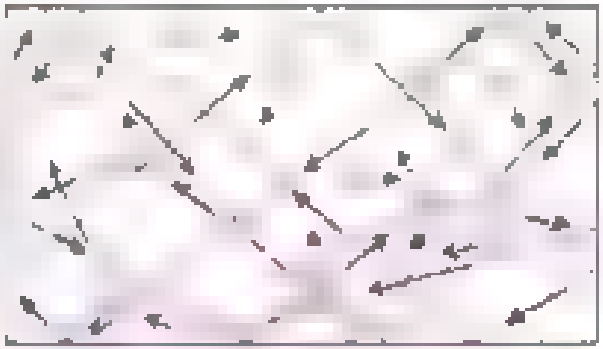


Fig. 7.6 The motion of gas molecules in a closed container

▪ More Pressure, Lower Volume

The volume of a gas and its pressure are inversely related. Decrease the volume and the pressure increases. As the volume a gas occupies decreases, the molecules of the gas are forced closer together, but their movement continues. They have less distance to travel to impact the container walls, so they strike more often, thus creating more pressure.

▪ Density of the Gas

Increase the number of particles in a container, and the pressure of the system within the container increases. More molecules mean more hits against the container walls. Increasing the number of particles means you have increased the density of the gas.

PNEUMATICS

➢ Explain how gases behave under pressure

Pneumatics is an aspect of science and engineering that is concerned with using the energy in compressed gas to make something move or work. The origins of pneumatics trace back to the first century when the Greek mathematician Hero of Alexandria created mechanical systems powered by wind and steam and documented his processes. Today, pneumatics plays an important role in manufacturing. Pneumatic systems are similar to hydraulics in function, but hydraulic systems use liquid instead of gas.

DO YOU KNOW?

The word Pneumatics comes from the Greek word pneuma, which means breath or wind.

Applications of Pneumatic Systems

➢ Identify the applications of gas pressure

The use of pneumatic Systems is not restricted to factories. You just need to have a look around and you will see them everywhere. In our daily life we use many items in which pneumatic systems

are present

A few common examples of things we use in our daily life that contain pneumatic Systems are

1 Spray Gun

Fig. Spray Gun

Spray gun a painting tool uses compressed air from a nozzle to atomize a liquid into a controlled pattern The spray nozzle operates by the effect of high velocity turbulent air on the surface of filaments or films of liquid, causing them to collapse to droplets with a wide range of sizes

2. Bicycle Pump

Fig. 7.5 Bicycle Pump

A *bicycle pump* is essential for keeping your tyres inflated The body of the bicycle pump is a cylinder and the handle is a plunger shaped to form a non return valve in the cylinder When you pull the pump handle out the plunger allows air to fill the cylinder and pushing the handle into the pump compresses the air until it is at a higher pressure than the air in the bicycle tyre. The valve in the tyre allows air into the tyre and closes when the pressure drops Each time the pump is pumped a little more air goes into the tyre until the tyre is at the correct pressure for riding

3 Vacuum Cleaner

A vacuum cleaner is a device that uses an air pump to create a partial vacuum to suck up dust and dirt usually from floors Compressed air vacuum cleaner is powerful, multi functional and easy to handle

4 Dental Drill

The dental drill is a tool used by dentists to bore through tooth

enamel as well as to clean and remove plaque from the tooth's surface. It is composed primarily of a hand piece, an air turbine and a tungsten carbide drill bit. The modern dental drill has enabled dentists to work more quickly and accurately than ever before, with less pain for the patient.

Fig. 9 Vacuum cleaner

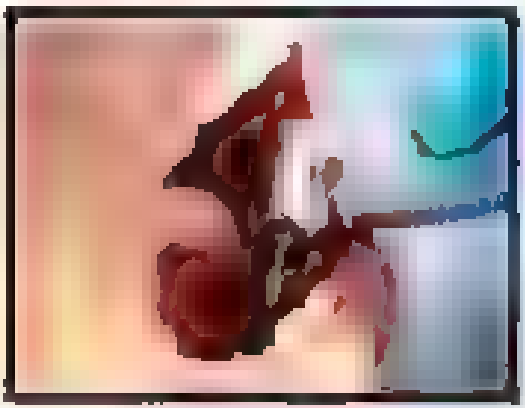


Fig. Dental drill

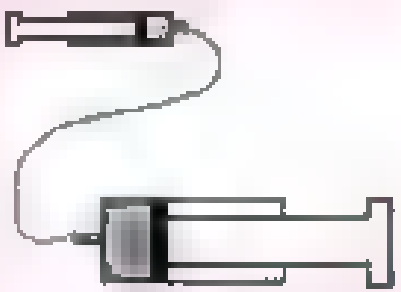
Activity 7.4

Controlling movement using a syringe attached to each end of plastic tubing

Materials

Two syringes of same size one syringe of different size,

Plastic Tubings



Procedure:

a) Using 2 syringes of the same size:

Push the end of one syringe fully in and attach the tubing to it

Push the end of the other syringe partly in and attach the tubing to it

Make sure that the syringes are not pushed out of the tubing

Questions:

1. Predict what will happen to the other syringe when you push one syringe in and out?

2. Why does this happen?

3 Can you compare the distances both syringes move?

b) Repeat the above activity using two different sized syringes.

4 Do you think the syringes will move the same distance this time?

5 Is there any connection between the size of the syringes and the distances they move?

AEROSOLS

➢ Explain the working of Aerosols

Aerosol is a system of particles uniformly distributed in a finely divided state through a gas. Aerosol particles, such as dust, play an important role in the precipitation process, providing the nuclei upon which condensation and freezing take place. Aerosols can be natural or artificial. Examples of natural aerosols are fog, geyser steam. Examples of artificial aerosols are haze, dust, particulate air pollutants and smoke.

Aerosols need no mixing or measuring and are always ready to use at the push of a button. This convenience is rated highly by people to use them in their daily life.

Uses of Aerosols in our daily life

Aerosols can perform a wide variety of tasks without the need for any additional equipment or tools Spray paints for example do away with the need for brushes rollers and tarps Aerosols are ideally suited to

1 Hair spray

2 Air freshener

- Producing fine space sprays such as air fresheners and insect sprays, achieving even coatings such as paints. hair sprays, surface spray insecticides and cooking sprays
- Producing foams such as carpet shampoo hair mousse and whipped cream

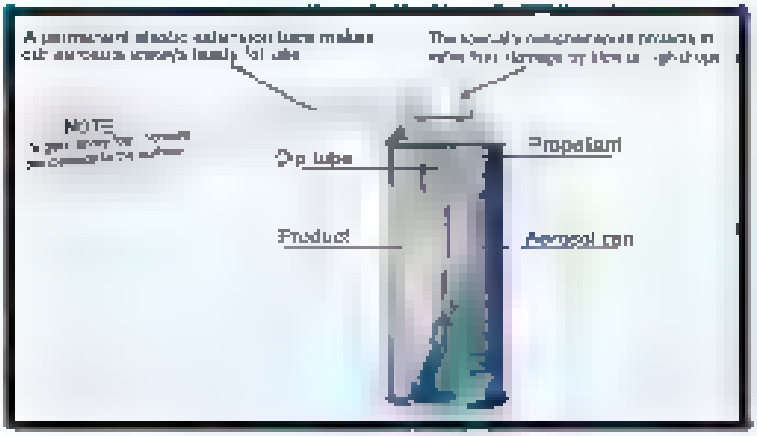
3 Inhaler

- Reaching hard to get places such as with automotive sprays lubricants and crack and crevice treatments
- Aerosols can dispense medicines or other products in metered doses down to 50mg
- Aerosols can pr. products long d stances for example yard and garden sprays, wasp sprays etc and One-shot or tota. discharge valves can empty the contents of a can in one hit making them ideal for fumigation and other similar applications

Principle and Working of Aerosols

Principle

A gas under enough pressure will turn into liquid, and when that pressure is relieved, will expand and turn back into a gas. That process is called Vaporization.



Working of Aerosol

Working

When the valve is open, the pressure on the liquid propellant is instantly reduced. With less pressure, it can begin to boil. Particles break free, forming a gas layer at the top of the can. This pressurized gas layer pushes the liquid product as well as some of the liquid propellant up the tube to the nozzle. Some cans, such as spray-paint cans, have a ball bearing inside. If you shake the can, the rattling ball bearing helps to mix up the propellant and the product, so the product is pushed out in a fine mist.

When the liquid flows through the nozzle, the propellant rapidly expands into gas. In some aerosol cans, this action helps to atomize the product, forming an extremely fine spray. In other designs, the evaporating propellant forms bubbles in the product, creating foam.

ATMOSPHERIC PRESSURE

▸ Describe the term Atmospheric Pressure

Atmosphere is a thick layer of air surrounds the earth. The air has mass and weight. Atmospheric pressure is defined as the force per unit area exerted against a surface by the weight of the air above that surface. In the diagram below, the pressure at point "X" is shown due to the

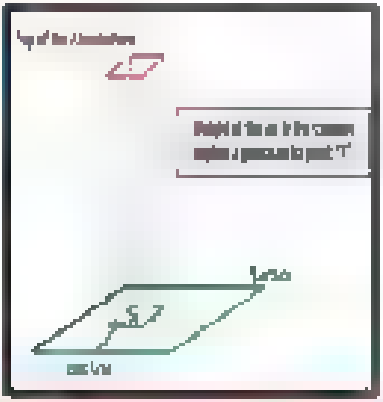


Fig. : Atmospheric pressure

wright of the air column above it. At sea level, this pressure is equivalent to about 1 Kg on every square centimetre.

Characteristics of Atmospheric Pressure

1. Atmospheric pressure varies with the height of the object above sea level. At higher altitude, the temperature and density of the air are lower. As a result, the frequency of the collision of molecules is lower. Thus, atmospheric pressure is lower.

2. Atmospheric pressure acts in all directions.

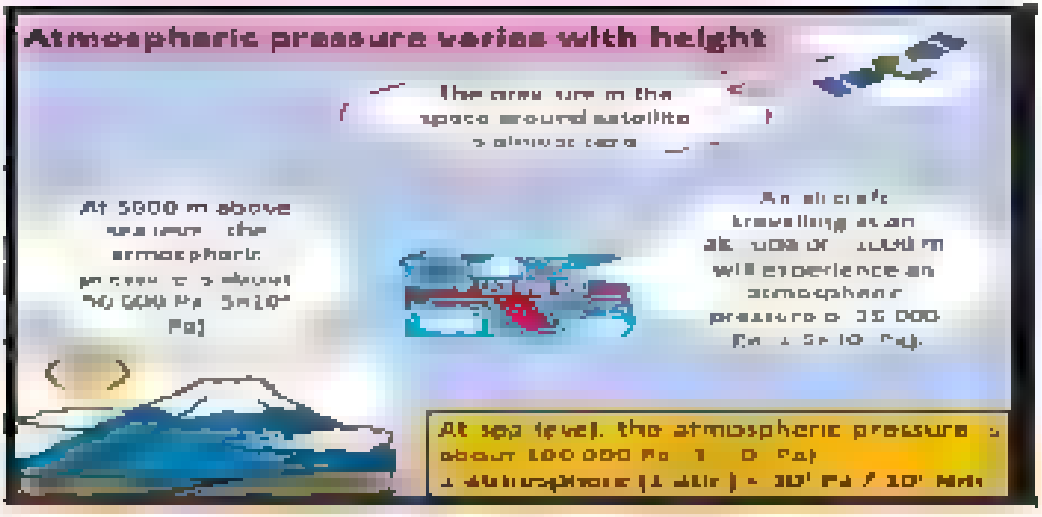


Fig. 6.4 Variation of Pressure with Height

DO YOU KNOW?

Why do your ears pop in airplanes?

As you go up in an airplane, the atmospheric pressure becomes lower than the pressure of the air inside your ears. Your ears pop because they are trying to equalize or match the pressure. The same thing happens when the plane is on the way down and your ears have to adjust to a higher atmospheric pressure.

Activity 7.5

Egg in a Bottle

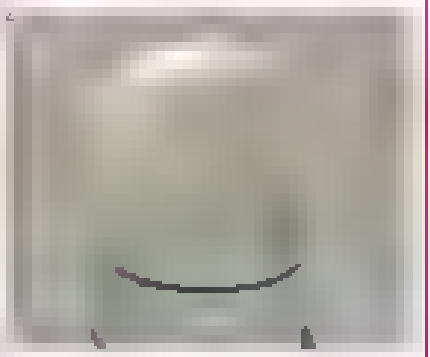
Materials:

a hard boiled egg, a glass bottle with a mouth just slightly smaller than the egg, 8-cm by 8-cm (3-inch by 3-inch) piece of newspaper, a match

Set up:

Remove the shell from the egg. Set the egg on the mouth of the bottle to see that the egg does not fit through the mouth.

Procedure:



1. Fold the piece of newspaper into a strip that can be dropped into the bottle, about 1 cm by 8 cm.
2. Light the match and use it to ignite the folded strip of paper. Remove the egg from the mouth of the bottle and drop the burning strip of paper into the bottle.
3. Before the fire goes out, set the egg back onto the mouth of the bottle. Within a few seconds the egg will squeeze through the mouth into the bottle.
4. As it entered the bottle, the egg may have broken into pieces. This happens when the diameter of the egg is more than about 0.5 cm (about 3/16 inch) larger than the diameter of the bottle's opening. A medium or small egg may be small enough to enter the bottle without breaking.

Questions:

1. Why does the egg slide into the bottle, even though no one is pushing it?

2. What happens when air is heated up?

Measuring Air Pressure

Air pressure can be measured through different devices. The most common device is called the barometer. In a barometer, a column of mercury in a glass tube rises or falls as the weight of the atmosphere changes. Meteorologists describe the atmospheric pressure by how high the mercury rises. An atmosphere (atm) is a unit of measurement equal to the average air pressure at sea level.

a temperature of 15 degrees Celsius. One atmosphere is 760 mm of mercury. Two most common types of barometers are the mercury and the aneroid barometer.

Mercury Barometer

Mercury Barometer is the simplest device to measure atmospheric pressure at a location. It consists of a glass tube closed at one end immersed in a container filled with mercury. Because of the atmospheric pressure mercury rises in the tube as shown.

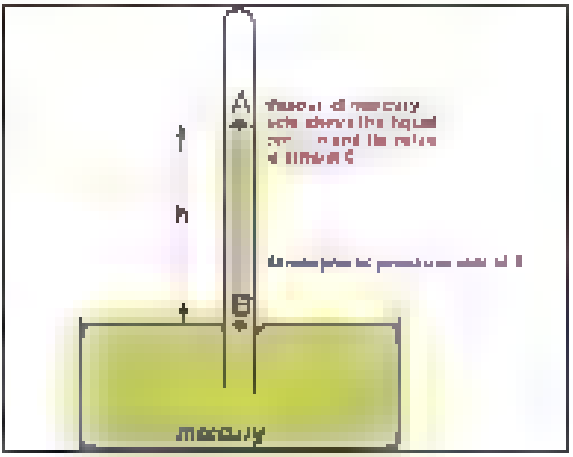


Fig. 7.17 Mercury Barometer

Aneroid Barometer

An aneroid barometer, has a sealed, air tight metal box inside. As the air pressure rises or falls, the box either squashes inward a tiny bit or bends outward. A spring is attached to the box and, as the box moves in and out in response to the changes in air pressure, the spring expands or contracts and moves the pointer on the dial. The dial is calibrated marked with numbers so you can read the air pressure easily. The Aneroid Barometer can be used as an altimeter by mountaineers or in an airplane to determine its altitude.

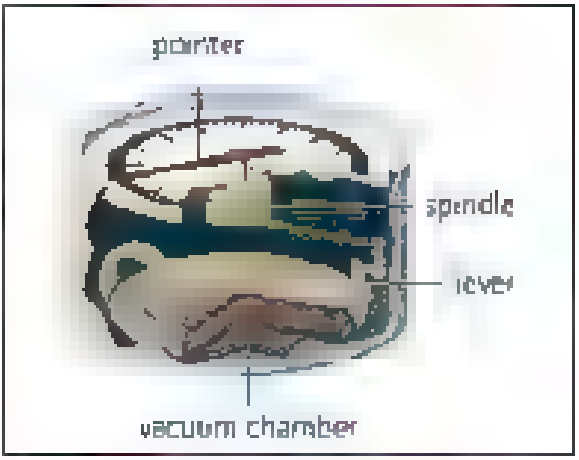


Fig. 7.18 Aneroid Barometer

SUMMARY

- Pressure is defined as the force per unit area
- The unit of pressure in the SI system is the pascal (Pa)
- Water pressure is a force that makes a flow of water strong or weak. It varies with the height of the water flow
- Pascal's Principal states that pressure applied to an enclosed liquid is transmitted equally to every part of the liquid
- Pascal's Principle is widely used in a Hydraulic System. Hydraulic Brakes, Hydraulic Jack system, Hydraulic Lifts are the commonly used Hydraulic systems.
- The particles in a gas move quickly in all directions. When gas particles hit the walls of their container they cause pressure
- Pneumatic technology deals with the study of behaviour and applications of compressed air
- Pneumatic systems are used in Spray guns, Pumps, dentistry tools etc.
- Pneumatic system uses air that is compressed in order to transmit and control energy
- An aerosol is a suspension of fine solid particles or liquid droplets, in air or another gas
- Atmospheric pressure is around us all the time
- The atmospheric pressure at sea level has a mean value of 101 325 pascals (roughly 14.7 pounds per square inch)
- A barometer is a scientific instrument used to measure atmospheric pressure

EXERCISE

Q1 Choose the correct answer

I Force has

a Magnitude
b. Direction
c Magnitude and direction both
d. None of these

II. What is the unit of pressure in SI units

a. Joule
b. Kg, m^2
c Newton
d Pascal

III Pressure increases when

a Area of contact is increased
b Area of contact is decreased
c Magnitude of force is decreased
d Area of contact remain same

IV The pressure in a liquid is transmitted equally in all directions. this principle is called

a Archimedes Principle
b Pascal's Principle
c Bernoulli's Principle
d Le Chatelier's Principle

V Atmospheric Pressure is calculated by the

a. Height of water column in barometer
b Height of mercury column in barometer
c Height of lime column in barometer
d Height of oil column in barometer

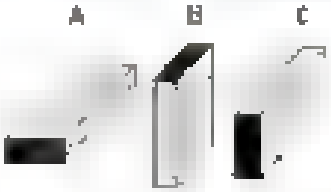
VI Amount of pressure of liquid increases with increase of

a Volume
b Depth
c Base area
d Mass

VII We may feel internal injury or altitude sickness at higher or lower altitudes than sea level because

a The pressure of our body remains the same
b Our body adjusts the pressure slowly
c Our body adjust the pressure quickly
d Our body unable to adjust the pressure

VIII A rectangular piece of wood is kept in 3 different ways on a table. Pressure exerted by the wood on the table will be

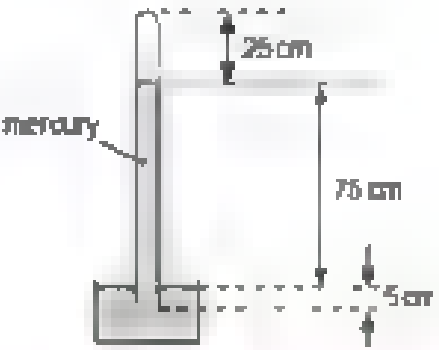


a Maximum in position A
b Maximum in position B
c Maximum in position C
d Equal in all cases

IX Which fluid is used in hydraulic power systems?
a Water
b Oil
c Non compressible fluid
d All of these

X Pressure in gases is due to
a Collision of molecules with walls of container
b The atmosphere
c Collision of molecules on base of container
d Collisions of molecules with each other

XI The diagram shows a mercury barometer. Which distance is used to calculate pressure of the atmosphere?
a 25 cm
b 75 cm
c 80 cm
d 100 cm



Q2 A large aquarium for fish is filled with water. The weight of the aquarium with the water is 10000N. The base of the aquarium has an area of 6m². Calculate the pressure exerted on the base of the aquarium by the water

Answer: P=6250Pa

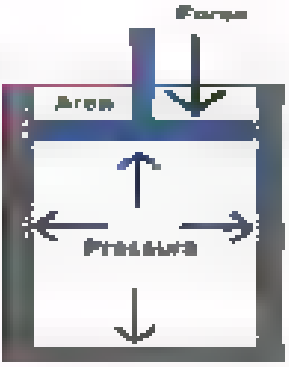
Q3 Imagine the atmospheric pressure at present is 101,200 Pa. You are holding your hand where the atmosphere is exerting a force of 'F' on your hand. If the area of your palm is 0.006 m^2, what is the force exerted on your hand

Answer: F=607 N

Q4 Look at the diagram to the right to answer this question:

If a force of 46N was applied to a system as you pushed it down and the area of piston is .5 m^2 then what would be the pressure inside the cylinder?

Answer: 92 N/m^2



Q5 Define Aerosol and explain the working of Aerosol

Q6 Why do cats have sharp claws?

Q7 A force of 300 N creates a pressure of 4 N/m^2. Over what area is the force acting?

Answer: 75m^2

Q8 State Pascal's Law and explain an application of this law

Project

Construct a simple model barometer

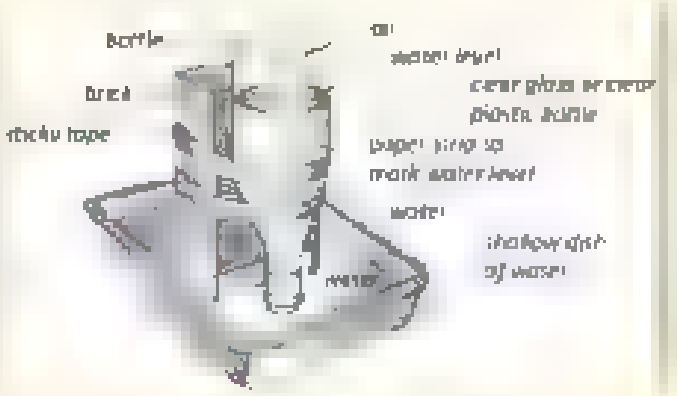
This model barometer is based on the variation of air pressure by changing the height of a column of water

Materials needed

1 long narrow clear glass bottle, a paper strip to mark the water level, a brick, sticky tape, a shallow dish and water

Procedure:

- First fill the glass bottle with water
- Hold the dish over the top of the bottle and turn the bottle upside down quickly and carefully
- The bottle should be about one-third filled with air. If necessary tilt the bottle slightly to let some more air in
- Tape the bottle to a brick so that it will not fall over and stick a strip of paper on the bottle and mark the level of the water at the start of work.



- Look at the barometer at the same time every day for a month. Each day write down the date, time, the weather, and whether the water level in the barometer is going up or going down (compared to the previous day). Remember, when the air pressure increases, the level of the water in the bottle will rise. When the air pressure falls, the level of the water in the bottle will fall. At the end of the month look at your results and discuss your observations with your teacher.

CHAPTER 8

MEASUREMENT OF PHYSICAL QUANTITIES

While buying milk for your home or cloth for your shirt, you must have noticed that the milkman measured the milk in a vessel reserved for the purpose and similarly clothier measured cloth by a meter rod. The process of comparing an unknown physical quantity with a known standard quantity of the same kind is called measurement. Measurement is essential to know the exact physical quantity of the substances in our daily life. The vessel of a milkman and rod of a clothier are the standards of the same kind used by them to compare the given quantity.

In this Chapter you will learn about:

- Physical Quantities (Length, Volume, Mass, Time)
- System International Unit (Meter, Litre, Kilogram, Second)
- Instruments for Measurements (Meter Ruler, Measuring Cylinder, Flasks, Pipette)

All the students will be able to:

- Define a physical quantity with examples
- Apply the prefixes milli, kilo, centi and interpret the units
- Interconvert smaller unit and bigger unit
- Select and use measuring instruments
- Interpret SI units in the daily life
- Investigate why it is desirable for a scientist to use the SI units in their work
- Measure the volume of liquid by reading correct meniscus

Fig. 8.1 Measuring instruments

PHYSICAL QUANTITIES

➢ Define a physical quantity with example

A physical quantity is a quantity that can be measured Or a physical quantity is a physical property that can be quantified Examples of physical quantities are mass amount of substance, length, time temperature, electric current, light intensity, force, velocity density and many other A physical quantity is always measured of objects A physical quantity can be expressed as the combination of a magnitude expressed by a number and a unit for example, a boy measured the length of a room as 3 m. Here 3 is the magnitude and m (meter) is the unit

Activity # 1
Measurement of Physical Quantities
Complete the table given below:

The marathon is about 40 km	Length	40	Km
A playground is measured to be 20 m²			
The weather forecast predicts that it will be 5 °C in Murree			
A glass of water usually means 240 ml			
My mother bought rice in a packing of 5 Kg			

The foundation of physics rests upon physical quantities, in which the laws of physics are expressed Therefore, these quantities must be measured accurately There are two types of physical quantities as discussed below

Physical Quantities

Fundamental Quantities

Those physical quantities, which can neither be derived from other quantities nor be further resolved into simpler ones are called fundamental quantities. For example, the length, mass and time

Derived Quantities

Those physical quantities which depend on two or more fundamental quantities or power of the fundamental quantity, are called derived quantities. For example area is a derived quantity. Area depends on the value of length and breadth. Other examples are volume and Pressure

A standard physical quantity is called unit. It is used to measure the other physical quantities of same kind

DO YOU KNOW?

The word measurement comes from the Greek word "metron" meaning limited proportion. Human arm, palm and foot were used by the ancient people for measurement. For example the Cubit terms used at that time were cubit, pace Fathom, Hand span, Foot, and Palm

a) Fundamental unit

Those units whose value does not depend on any other units are fundamental units. For example, length of an object is metre, the mass of an object is kilogram, time is second

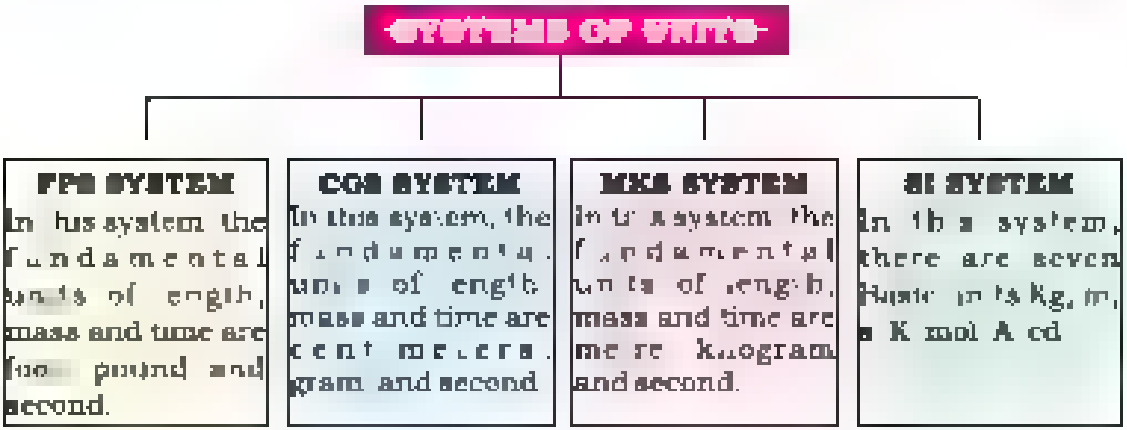
b) Derived Unit:

Those units whose value depends on other units are derived units. For example, to measure the velocity of a car we must know the distance metre (m) travelled by car and time second (s) taken by the car to travel the distance

SYSTEM INTERNATIONAL UNITS

- Apply the prefixes milli, kilo, centi and interpret the units
- Interconvert smaller unit and bigger unit
- Interpret SI units in daily life
- Investigate why it is desirable for a scientist to use the SI units in their work

There are different units of fundamental quantities that combine to form a system of units. Some of these systems are



The different systems of units discussed above are useful in some situations. But at the human sized level, SI measures well most things that we work with. Therefore, it was decided in 1960 that SI system of units should be implemented in all countries of the world as a single standard system of units.

Why SI System is Preferred?

- SI is based on precise and definite standards
- SI uses base 10 unlike our number system, so it is much easier to learn, remember and convert between units
- The prefixes used in SI are from Latin and Greek and they refer to the numbers that the terms represent (For example 'kilo' as in 'kilogram' means 1000 and 'milli' means 1000). You can now easily calculate the number of mm in a km.
- SI units are interrelated in such a way that one unit is derived from other units without conversion factors e.g. 1N (Newton) is the force needed to give 1kg (kilogram) of mass an acceleration of 1m/s
- SI is used in most places around the world, so our use of it allows scientists from disparate regions to use a single standard in communicating their data without vocabulary confusion.

SI System of Units

Physical Quantity	Name of Unit	Abbreviation
Mass	Kilogram	kg
Length	Meter	m
Time	Second	s
Temperature	Kelvin	K
Amount of substance	Mole	mol
Electric current	Ampere	A
Luminous intensity	Candela	cd

Multiples and Submultiples of Units

The multiples and submultiples are given below

Length			Time		
10 millimeter	=	1 centimeter	1 hour	=	60 minutes
10 centimeter	=	1 decimeter	1 minutes	=	60 seconds
10 decimeter	=	1 meter	1 hour	=	3600 seconds
10 meter	=	1 decameter	1 milli second	=	10^{-3} seconds
10 decameter	=	1 hectometer	1micro second	=	10^{-6} seconds
10 hectometer	=	1 kilometer	1 nano second	=	10^{-9} seconds

Prefixes

These are the letters or words that added before SI units. When we talk about very big or very small numbers, we add prefixes that present powers of 10. The table of prefixes is given below for further details

Prefix	Symbol	Factor	Prefix	Symbol	Factor
nano	n	10^{-9}	deca	da	10^{1}
micro	μ	10^{-6}	hecto	h	10^{2}
milli	m	10^{-3}	kilo	k	10^{3}
centi	c	10^{-2}	mega	M	10^{6}
deci	d	10^{-1}	giga	G	10^{9}

Example 1: If you are asked to change a unit with a prefix into one without prefix, multiply the number with the factor of the prefix.

1. 400 **mg** = ... g

400 **x** 10^{-3} g = 0.4 g

2. 0.025 **km** = ... m

0.025 x 10^{3} m = 25 m

3. 500 **ml** = ...

500 x 10^{-3} l = 0.5 l

Example 2: If you are asked to change a unit without prefix into one with prefix, divide the number with the factor of the prefix.

1. 3.9 m = ... **cm**

3.9 ÷ 10^{-2} = 390 cm

2. 5000 Hz = ... **MHz**

5000 ÷ 10^{6} = 0.005 Mhz

Activity 8.2

Using Prefix

Rewrite the following quantities, making use of suitable prefixes

1. The height of K2 mountain is 8848 m =
2. The average diameter of Earth is 12 742 000m =
3. A Cricket ball is of about 155.9 g =
4. Volume of blood in an average human adult is 5000 ml =
5. The size of grain of table salt is approximately 0.03 cm =

INSTRUMENTS FOR MEASUREMENTS

- Select and use measuring instruments

If we want to know how long and wide our dining table is or how heavy our Sofa set is or how much space our new bed takes up in our bedroom, then we need something which provide us accurate measurement. Devices used for the measurements of physical quantities such as length, mass, volume are called measuring instruments.

Activity 8.3

Conversion of Units

Find the following measurements and convert them into the suggested units

Mass of your bag is		kg	=	g
Width of classroom door opening is		cm	=	m
Length of your pen is		mm	=	cm
The volume of your water bottle is		m.	=	
Duration of your science period is		min	=	s

Some of the common instruments used in Science Laboratories are

1. **Meter Rule**

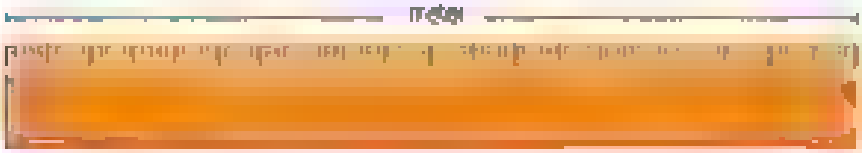


Fig 8.2 Meter Rule

It is a device which is used to measure length, height and width of different objects or the distance between two points, objects or places. A meter rule is a graduated stick of wood, plastic or metal with a length of 1m. This 1 meter length is divided into 100 equal parts, each part is equal to 100 centimeters (cm). On meter rule each cm is divided further into 10 divisions which are called millimeters (mm). So a meter rule can measure up to 1mm as the smallest reading.

Precautions to be taken when using meter rule.

- Avoid zero error or end errors
- Observe the scale from straight point
- If the ends of the ruler worn-out, it is advisable that the measurement should be started from 1 cm of the scale

Fig 8.3 Reading meter Rule

Activity 8.4

Measurement of Height

Measure the height of your classmate using hand span and then by using a meter scale

You need: A meter Scale, A chalk

Steps:

1. Ask your classmate to stand with his back against a wall and make a mark on the wall exactly above his head.
2. Measure the distance from the floor to this mark on the wall with your handspan and then with a meter scale. Let all other students measure this length in a similar way.
3. Record all observations in Table given below.
4. Carefully study the results obtained by different students.

Who measured the height?	Height in handspans	Height in cm

Conclusion

A standard scale provides more precise and accurate reading than the other ordinary methods.

2. Measuring Cylinder

A measuring cylinder is used in a laboratory for measuring exact volume of a liquid. It is a narrow cylindrical container of glass or plastic marked with horizontal lines to represent units of measurement. It is also called a graduated cylinder, as

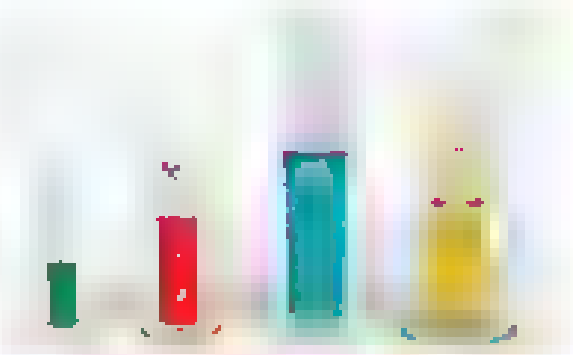


Fig 8.4 Measuring cylinders

it is marked with precise measurements in milliliter and centimeter cube

When taking measurements it is important to hold the graduated cylinder at eye level and record the measurement at the bottom of the meniscus. This process provides the most accurate measurement.

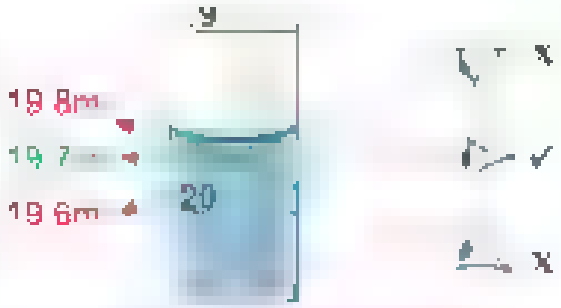
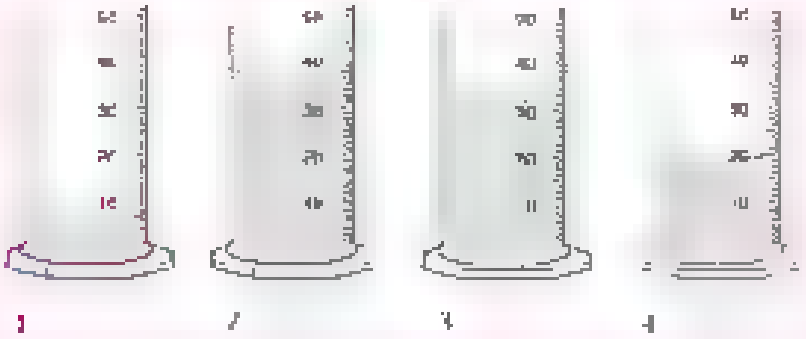


Fig 8.5 Reading Measuring Cylinder

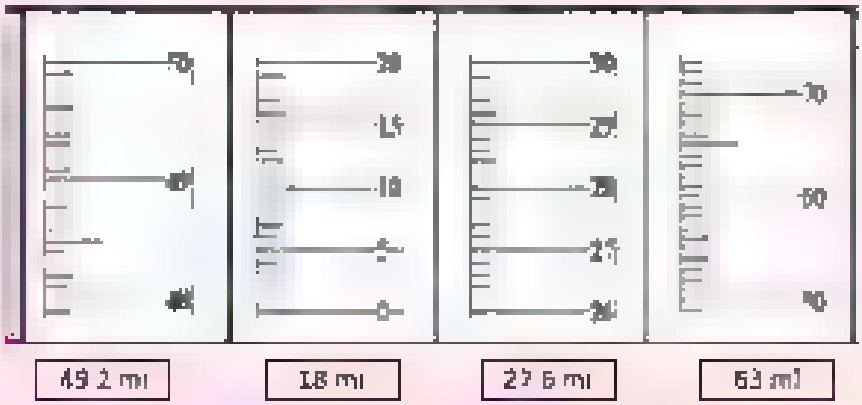
Activity 8.5:

Volumetric measurements using Measuring Cylinder

A Given the following measuring cylinders (calibrated in ml) determine the volume of the liquids in the following graduated cylinders



B Draw in the meniscus for the following readings.



3 Flasks

Figure 8.6 Conical Flasks

A flask is a narrow-necked glass or plastic container, typically conical or spherical, used in a laboratory to hold reagents or samples and for measuring volume in the preparation of solutions at room temperature. These flasks are calibrated using global standards and are considered the most precise way of measuring liquids in comparison to cylinders. The common sizes of the flasks available in the laboratories range from 50 ml to 1000 ml.

4. Pipettes

Fig. 8.7 Pipettes

A pipette is a calibrated narrow glass or plastic tube often with an enlarged bulb used for transferring measured volumes of liquids. It is one of the most extensively used tools in a laboratory for transferring small amount of liquids when high degree of accuracy is desired. The most commonly used sizes are 5 ml, 10 ml, 15 ml, 20 ml and 25 ml. The capacity and calibration temperature are clearly mentioned on the bulb of the pipette.

DO YOU KNOW?

The main purpose of pipette bulb is to decrease the surface area per unit volume and to diminish the possible error resulting from water film.

SUMMARY

- Measurement is a comparative process in which we compare a physical quantity with a standard physical quantity of same kind
- The quantity which can be measured is called a physical quantity
- A standard physical quantity is called unit. There are different units of physical quantities that combine to form a system of units
- SI system of units includes seven basic units.
- Prefixes are used to form decimal multiples and submultiples of SI units
- For precision in our measurement we need measuring instruments
- Meter scale is used for measuring length, width and height of objects with accuracy
- The position of the eye must be inline with the reading to be taken to avoid any error in reading
- For the measurement of exact volume of a liquid measuring cylinders are used in laboratories
- Flasks are the glass or plastic containers used in the science laboratories to hold the reagents and samples.
- A pipette is used for transferring measured volume of liquids

EXERCISE

Q1. Choose the correct answer

A quantity that can be measured is called

a) Physical quantity b) measurable quantity

c) Standard quantity d) it depends on temperature

ii. Which one of the following units is a fundamental unit

a) Newton b) Second c) Watt d) Joule

When a standard is set for a quantity then standard quantity is called

a) amount b) rate c) prefix d) unit

iv. What is the correct order in increasing size for measurement of length?

a) kilometer centimeter meter b) meter centimeter millimeter

c) millimeter, centimeter, meter d) millimeter meter centimeter

v. A mass of 4 kg is equal to

a) 4000mg b) 4000g c) 400g d) 40g

vi. 0.05 kilometer is equal to

a) 5dcm b) 5000m c) 15m d) 5dm

vii. 10^{-9} second is called as

a) micro second b) nano second

c) macro second d) milli second

viii. The unit of electric current in SI system is

a) Ampere b) Kelvin c) second d) coulomb

ix. Cubic meter is a unit of

a) Volume b) Length c) Area d) Mass

x. A measuring cylinder is used in laboratories for measuring

a) mass b) weight

c) temperature d) volume

Q2 What are the two components that make up a physical quantity?

Q3 What are the seven basic physical quantities and their SI units?

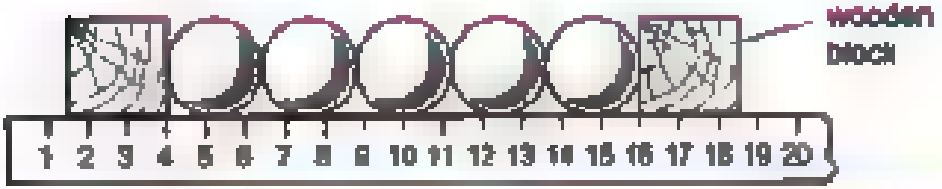
Q4 What are prefixes? How to convert prefixes back to their respective SI units?

Q5 Explain that the volume measurements with a graduated cylinder are precise?

Q6 Complete the table given below.

Basic Physical Quantities	Name of Unit	Symbol for Unit
Length		
	Ampere	
Mass		
		s
	Kelvin	
		mol
Luminous intensity		

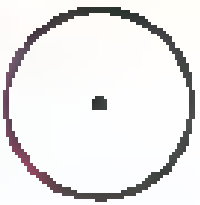
Q7 Five spheres are placed side by side and their combined length was measured. Calculate the diameter of one sphere?



Q8 Record the measurements of following objects in the table below

Objects	Measured Volume
Area of your reading table at your home	cm^2
Length of your school shoes	mm
Breadth of your classroom	m

Q9 Use a meter rule marked in centimeter (cm) and millimeter (mm)



1. Measure the diameter of the circle mm
2. Now, convert its diameter in centimeter cm

Q10 Choose the instrument from the box below that you would use to measure each of the following

i) the size of your textbook
ii) the size of your classroom table
iii) to transfer 10 mL of a liquid with accuracy in science lab
iv) to hold 500 mL of a reagent in science laboratory

30 cm ruler	flask	meter ruler	pipette

CHAPTER 9

SOURCES AND EFFECTS OF HEAT ENERGY

In your previous class you have already learnt about transmission of heat and three different modes of heat transfer i.e. conduction, convection and radiation. In this chapter you will further explore about the sources and effects of heat energy. You already know that sun is the major natural source of heat and light during day time. Heat reaches to the earth in the form of radiation. Have you ever wondered about other natural sources of heat? Do you know why do we use artificial sources to generate heat? Have you ever thought why heat is so important for living things? What are the effects of heat in our daily life? How do solids, liquids and gases contract and expand? Let's explore these and many other related questions.

In this Chapter you will learn about:

- Sources and Effects of Heat
- Thermal Expansion and Contraction (Solids, Liquids and Gases)
- Applications of expansion and contraction of solids (Riveting, Fixing a Metal Tyre into Wheel, Fixing Axle of a Wheel, Fish Joint and Electric Coil)
- Effects of Expansion and Contraction of solids in everyday life (Concrete Road Surfaces, Railway Tracks, Bridges, Overhead power and Telephone lines, Pipelines)
- Uses of Expansion and Contraction of liquid
- Peculiar Behaviour of Water during Contraction and Expansion

All the students will be able to:

- Distinguish between heat and temperature
- Explain thermal expansion of solids, liquids and gases
- Explain the effects and applications of expansion and contraction of solids
- Describe the uses of expansion and contraction of liquids
- Explain the peculiar behaviour of water during contraction and expansion
- Investigate the processes making use of thermal expansion of substances
- Identify the damages caused by expansion and contraction in our surroundings and suggest ways to reduce the damages
- Investigate the precautions taken by architects and engineers to overcome the problems of expansion and contraction in everyday life
- Describe the working of a thermometer

Fig. 9.1 Sources of Heat Energy

Fig. 9.2 Thermal expansion in Solid

SOURCES AND EFFECTS OF HEAT

➢ Describe the sources and effects of Heat

Heat is a form of energy found due to the random motion or vibration of atoms, molecules and ions. You have already learnt that heat energy is the capacity for action or performing work and it flows from a region of higher temperature to the region of lower temperature. It means heat flows from things that are hot. Sun is the natural source of heat energy while artificial sources are wood, coal, electricity, oil and gas.

Fig 9 : Effects of heat

Heat energy brings out chemical changes in a substance, for example, when marble ($CaCO_3$ calcium carbonate) is heated it turns into calcium oxide (CaO) and carbon dioxide (CO_2). Also, a body may catch fire if it is sufficiently heated. The burning of substance in air with the release of large amount of heat and light energy is called combustion.

THERMAL EXPANSION AND CONTRACTION (SOLIDS, LIQUIDS AND GASES)

➢ Explain thermal expansion of solids, liquids and gases

Thermal expansion of solids, liquids and gases is the increase of the size (length, area and volume) of a body due to a change in temperature. While decrease in size (length, area and volume) of a body due to change in temperature is called thermal contraction.

All the three states of matter solids, liquids and gases expands upon heating and contract upon cooling. Thermal expansion is large for gases and relatively small for liquids and solids. Let us explore the effects and application of thermal expansion, contraction, and its effects and applications in solids.

- Explore the effects and applications of expansion and contraction of solids

a) Thermal Expansion of Solids

You have learnt in your previous class that material objects solids, liquids and gases are made up of tiny particles, atoms and molecules. In solids, particles are closely packed with each other. When solids are heated the vibratory motion of their particles (atoms and molecules) become fast and they begin to push each other further apart thus results into expansion of solids. Similarly, when solids are cooled particles slow down, come closer to each other and solids contract. The expansion and contraction caused by heat is also known as thermal expansion or contraction respectively. It means heat energy or thermal energy can change the length of solids and volume of liquids and gases. You may have noticed that the telephone and electric wires are not hung tightly and left slack. Why? Also, these wires are loosened during hot summer season, why? What change in the length of wires have you observed during winter season?

Fig 9.4 Electrical Wires are left slack

Wires are left slack so that they are free to change length. Let us perform a simple activity to understand this phenomenon easily through experiment.

Activity 9.1

Exploring thermal expansion in solids

What I need?

- One-meter long copper wire
- Iron stand to be used to suspend the fully stretched copper wire
- Candle/spirit lamp
- Match box

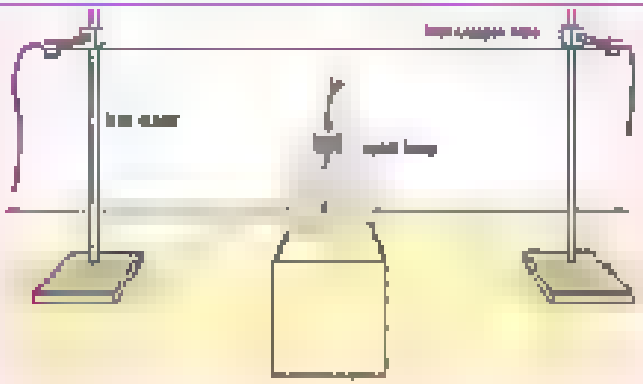


Fig. 9.5 Experimental arrangement showing heating of copper wire with spirit lamp

What to do?

1. Wind a one-meter long copper wire around the two iron stands
2. Wire should be suspended in fully stretched position as shown in Figure 9.5
3. Place the candle spirit lamp under the wire in the middle
4. Heat the wire with candle spirit lamp. Do not touch the wire after heating
5. Heat a few minutes. What happened to the length of wire? Record your observation and its reason.

What I Observed?

Activity Questions.

1. Why does the wire loosen and sink after heating?
2. What does the heat cause to the molecules of copper wire?
3. What happened to the length of the wire upon heating?
4. What happened to the length of wire after cooling?

What I Concluded?

➢ Describe the uses of expansion and contraction of liquids

b) Thermal expansion of liquids

Have you ever noticed that the liquid mercury in the thermometer rises on heating and falls on cooling? Let us explore

In a liquid, expansion occurs when heated. The particles move faster around each other and expand. An example of expansion in a liquid is ocean. In hot climate the water expands, and the sea level rises due to the heat of the sun besides the hot weather. Contraction happens in liquids upon cooling

c) Thermal expansion of gases

Activity 9.2:

Exploring thermal expansion of air (Mixture of gases)

What I need?

1. Two bowls / water trough
2. One litre plastic bottle
3. One balloon
4. Hot water from the tap (do not use boiling water)
5. Cold water with ice cubes

What to do?

1. Take some hot water from the tap in one bowl (if hot tap water is not available then heat the water on stove in a kettle in the supervision of teacher)
2. Take cold water with ice cubes in the other bowl.
3. Blow the balloon up to stretch so that the balloon would become more flexible. Place this balloon over the mouth of the one litre plastic bottle (do remember that this bottle is not empty, it has air which is the mixture of gases)
4. Predict what will happen when you will place this bottle with balloon in hot water and then in cold water. Discuss all responses.
5. Now place the bottle in the centre of the bowl filled with hot water. Wait a few minutes observe and see whether your predictions were right or wrong.
6. Record your observations.
7. Remove the bottle from the hot water bowl and place it in the bowl containing cold water and ice.
8. Wait for few moments and observe the balloon. Record your observation.

What I observed:

When bottle was placed in hot water

When bottle was placed in a bowl containing cold water and ice

ACTIVITY QUESTIONS:

1. Why it is necessary to blow and stretch the balloon before placing it on mouth of the bottle
2. Why the balloon filled with air was inflated upon placing the bottle in hot water?

3 Why the balloon was deflated when you placed the bottle in cold water?

4 Explain and draw the movement of particles in the bottle when it was

a in hot water bowl b in cold water bowl

What I Concluded

DO YOU KNOW?

In the above experiment the heat from hot water was sufficient to expand the air present in the bottle considerably. Solids, however expand much less than gases.

All three states of matter expand upon heating because particles absorb heat and move further apart and hence, take more space. While upon cooling particles come closer and hence, it contracts and gets smaller. The initial binding forces that had kept the particles bound, now become inadequate to maintain the same form or structure. As a result, the drifting of particles causes expansion. In contrast, cooling down of particles leads to more condensation of the material. Lesser movement of particles and thus lead to contraction of matter.

If the gases are heated in a closed container, the particles collide with the sides of the container and cause pressure. When the number of collisions increases, the pressure also increases. According to the particle theory of gases, when particles are heated they move faster. As a result, gas occupies more space it is called expansion.

THE PECULIAR BEHAVIOUR OF WATER DURING EXPANSION AND CONTRACTION

✓ Explain the peculiar behaviour of water during expansion and contraction

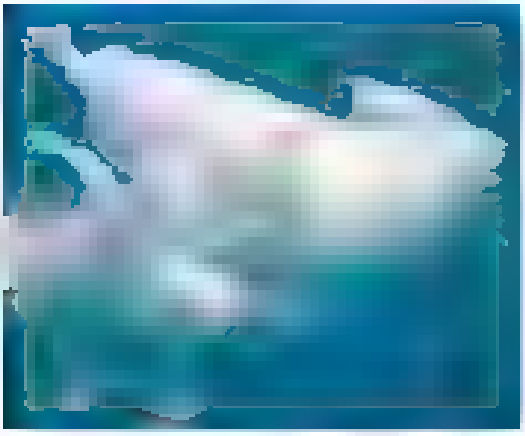


Fig. 7.5 Frozen water ice berg in sea

Fig. 7.6 Fish and aquatic plants under frozen water during winter season

When the temperature increases or decreases the water behaves quite differently from other liquids. On cooling from 4°C to 0°C water solidifies (freezes) as ice its volume increases and density decreases. As a result, ice floats on the top of Liquid water. This property of water helps aquatic animals and plant to survive in cold countries during winter season. Ice floats on the water surface and fish and other animals live underneath frozen lakes and ponds.

APPLICATION OF EXPANSION AND CONTRACTION OF SOLIDS

✓ Investigate the processes making use of thermal expansion of substance

Mostly solids expand (increase in volume) when they are heated and contract (decreased in volume) when they are cooled. It means change in shape, area and volume occurs due to heating or cooling. Thermal expansion, followed by contraction upon cooling, is used in solids in the following processes.

1 **Riveting:** Rivet is a steel bolt used as permanent mechanical fastener. A rivet consists of a smooth cylindrical shaft with a head on one end. The end opposite to the head is called the tail. Before installation, a rivet is heated over a very strong flame. On installation the rivet is placed in a punched or predrilled hole and the tail is deformed or flattened with a hammer so that it expands to about 1.5 times the original shaft diameter. This fixes the rivet in place. When the rivet cools down, it contracts and holds the two metal plates tightly together. Rivets can fasten hard materials such as wood, metal, and plastic. Rivets are commonly used in home building, wall and ceiling decorations and signs, wood working, Jewellery and aircrafts.

Fig. 9.7 Rivet

2. **Fixing a metal tyre onto a wheel:** The cool metal tyre is too small to fit into the wheel, therefore, it is heated. When the metal tyre is heated it expands and wheel can then fit in it loosely. However upon cooling the tyre contracts and fits on the wheel tightly.

Fig. 9.8 Metal tyre fixed onto wooden wheel after heating

3. **Fixing axel of a wheel:** Mostly wheels of trains are fixed in axels by this method. As you have experienced that metal contracts upon cooling, this property of metals is used in this method. The diameter of axel is kept slightly larger than the hub of the metal wheel. Therefore, in order to contract it, it is placed in liquid nitrogen at $-190^{\circ}C$. The axel cools and contracts or shrinks until it can be fitted into the hub of the wheel. Then at room temperature it expands and fits into the wheel tightly.

Fig. 9.9 Axel of a wheel

4. **Applications of Bimetallic Strips:** Bimetallic strips are used in thermostats of electrical appliances to control the temperature. Bimetallic strip is made up of two metal strips joined together usually one strip is of steel and the other is of brass. One metal strip of bimetallic strip expands much more than the other upon heating. At room temperature the strip is flat. When heated the strip curves because the brass expands more than steel. This causes the strip to bend towards steel side. The bimetallic strip can be used as a switch to close or open a circuit. It is used in thermostats. Thermostats keep temperature constant in appliances such as electric irons, heaters, oven, fire alarms, air conditioners, car thermostat and refrigerators.

Fig. 9.10 Bimetallic Strip

Fig. 9.11 Bimetallic strip after heating

a) **Electric Iron:** Thermostat in an electric iron, controls the temperature of iron. When electric current flows through its heating element, it becomes hot. Bimetallic strip connected with the heating element through a spring also heats up. As a result, bimetallic strip bends and is disconnected from the heating element. This makes the circuit open and switches OFF the electric iron. On cooling the bimetallic strip straightens. The circuit is again closed, and the iron is switched ON.

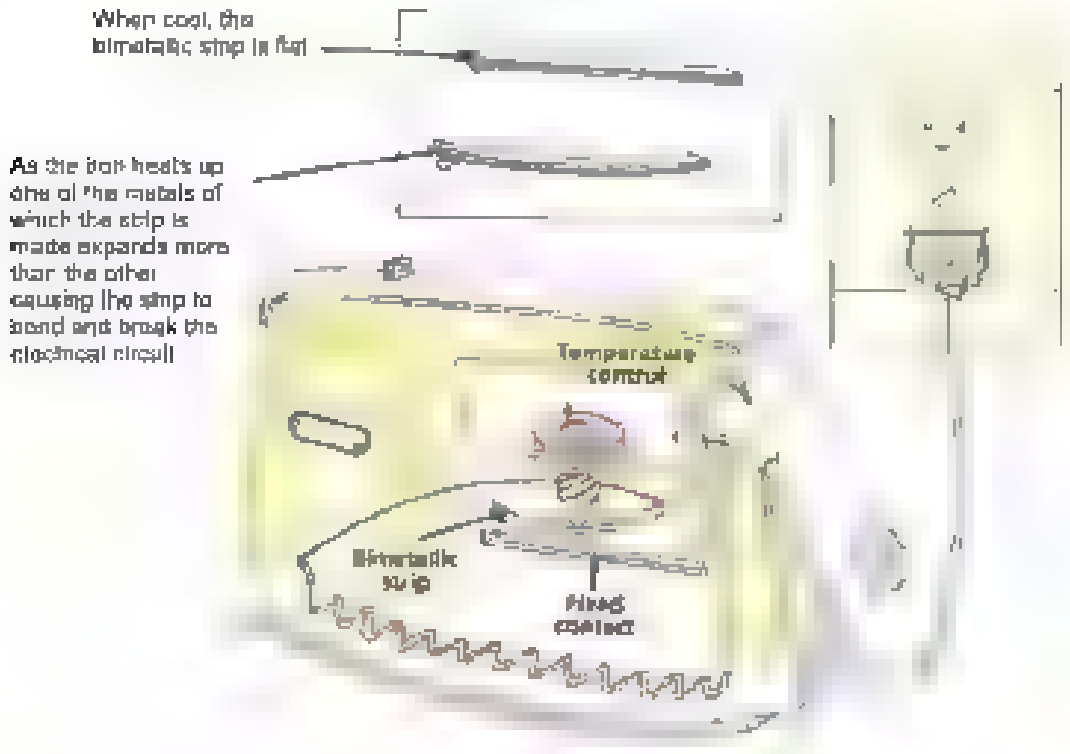


Fig 9.2 Electric iron

Fire Alarm. Bimetallic strip made up of brass and iron strips is used in fire alarms as shown in Fig 9.13. When fire breaks out, the bimetallic strip used in the fire alarm becomes hot and bends. Upon bending it touches the contact point of the battery to complete the circuit and the bell connected in the circuit starts to ring to warn of the fire.

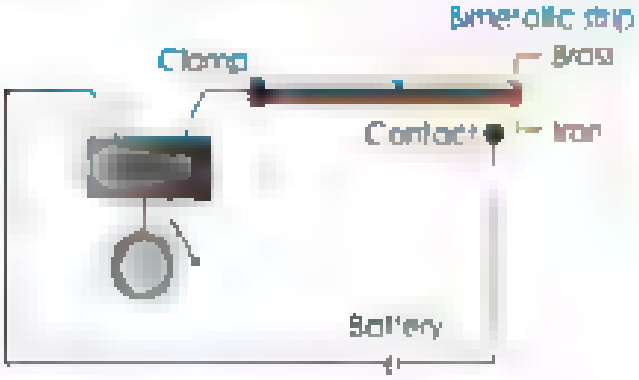


Fig. 9.3 Circuit Diagram of Fire Alarm

Fig. 9.4 Fire Alarm

EFFECTS OF EXPANSION AND CONTRACTION OF SOLIDS IN EVERYDAY LIFE

- Identify the damages caused by expansion and contraction in their surrounding and suggest ways to reduce the damages
- Investigate the means used by scientist and engineers to overcome the problems of expansion and contraction in everyday life

Expansion and contraction of solids create problems. However, scientists and engineers have developed methods to overcome these problems. Some of these are given below

1 Cracking of Roads and footpaths

One disadvantage is the cracking of concrete roads and footpaths due to the expansion during hot summer days and contraction during comparatively cold nights. This expansion and contraction make road surface rough. Due to fluctuation in temperature, concrete structure expands or contracts slightly. Temperature change may be caused by environmental conditions or cement dehydration. This simultaneous decrease and increase in size due to change in temperature leads to cracking of structures. In order to overcome this problem, two basic techniques are used

- **Crack Control Joints**: The most widely used technique to control random cracking in concrete slabs of footpaths and roads is crack control joints. These joints must be established to a depth of the slab thickness. Proper joint

spacing and depth are essential to effective control of random cracking

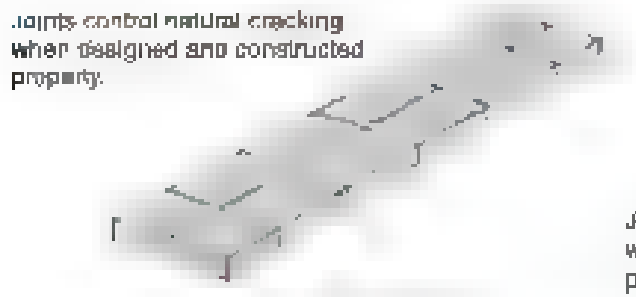


Fig. 9.5 Cracks and joints

Joints control natural cracking when designed and constructed properly

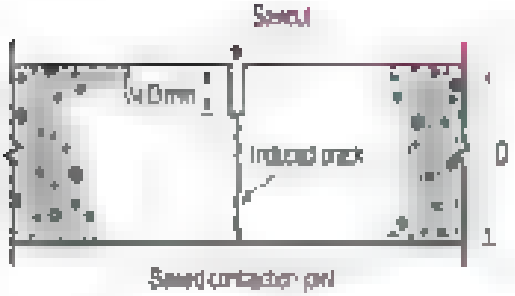


Fig. 9.6 Contraction joint filled with saw

Fig. 9.7 Crack and joints

- **Steel Reinforcement.** Another technique is to provide steel reinforcement in the slab and structures which holds random cracks tightly. When cracks are held tightly or remain small the aggregate particles on the faces of crack interlock, thus provide load transfer across the crack.

Fig. 9.8 Steel Reinforcement in Building

2 Railway tracks.

Have you observed railway tracks? Why two sections of railway tracks are not welded together? These gaps are meant to control the expansion and contraction during summer and winter seasons. Thus these gaps prevent railway tracks to de-shape and

create hindrance in smooth running of rail. If they are not designed for expansion, then the entire track may bend out of shape during expansion. Rails and bridges expand in hot weather, which can cause them to buckle or break. Railway engineers leave gaps between sections of railway track, which gives the sections room to expand and gives trains their characteristic clackety clack noise when their wheels run over the gaps.

Fig. 9.19 A railway track with gaps between rails

3 Expansion of bridges

Metal and steel structures used in bridges also expand when they heat up, causing fractures in the bridges. Therefore, girders in buildings and bridges are made with gaps at the end. Bridges can be built in sections, connected by expandable joints as shown in Fig. 9.20. Predict what will happen if bridges are not designed for the expansion?

Fig. 9.20 A bridge expansion joint

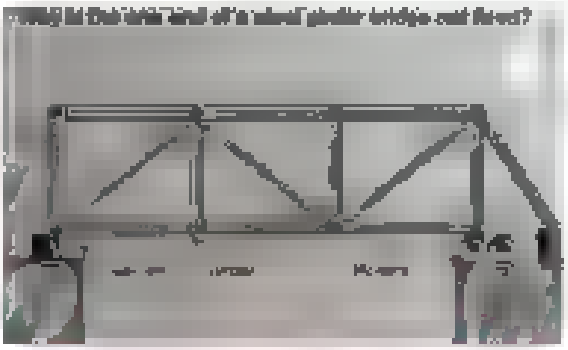


Fig. 9.21 One end of a steel girder bridge is not fixed

DO YOU KNOW?

1. Oven mitts are used to avoid the extreme of heat of the ovens and pans while cooking.
2. Ski suits prevent skiers to get frost bite by insulating their body from cold.

USES OF EXPANSION AND CONTRACTION OF LIQUIDS

- Describe the uses of expansion and contraction of liquids

Large Bends in Pipes. Water and steam pipes often have a U bend in them to allow for thermal expansion. In cold weather liquid or gas in pipes freezes and due to expansion frozen pipes burst. Similarly when hot liquid or gas flows through pipes they may crack due to expansion or contraction. In order to resolve this problem large bends are given in pipes. The pipes used for transport of petroleum are usually coiled. The coils and curves allow for expansion and contraction so that the pipes may not be damaged.

Fig. 4.23 Large bends in pipes

THERMOMETER

- Describe the working of a thermometer

As you have already explored liquids expand upon heating and contract upon cooling. This property of liquids is used in Thermometer for measuring the temperature. Let us explore how thermometer is constructed and works.

In a thermometer thermal expansion and contraction of liquid mercury or alcohol is used to measure temperature. You must

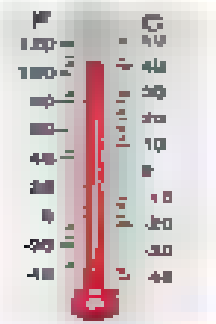


Fig. 4.24 Alcohol Thermometer

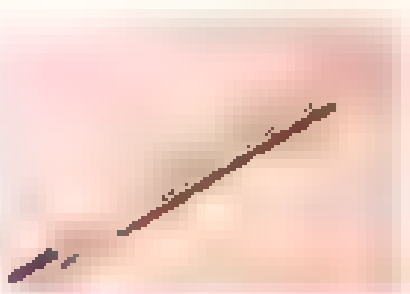
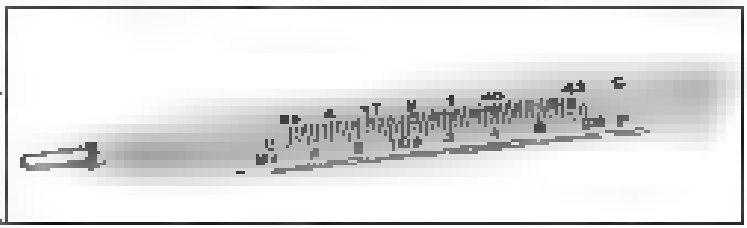


Fig. 4.25 Clinical Thermometer

have used a mercury thermometer to measure your fever when you are sick. Our normal body temperature is 98.6 degree Fahrenheit (98.6° F). The liquid mercury in a bulb thermometer when heated expands and rises up in the narrow capillary tube.

Mercury thermometer has a thin walled glass bulb filled with mercury and the bulb is attached to a thick walled glass tube. Liquid expands more than solids. When we place the bulb of thermometer in our mouth under the tongue, mercury of bulb expands and rises in the tube which has linear scale 94° to 108°F (35°C to 42°C). In alcohol thermometers, stained red ethanol is used and temperature can be measured on the scale as alcohol rises through the capillary.



SUMMARY

Sources of Heat Energy

Sun Earth Wood Coal Methane Electricity Petroleum Water Oil

- Heat is the form of energy found due to the movements of atoms and molecules
- All material objects solids liquids and gases have ability to expand upon heating and contract upon cooling
- In hot summer days expansion of solids can cause damages. Roads crack because these expand during summer season and contract during the cold season
- Expansion gaps in concrete roads and railway tracks are used to avoid harmful effects of expansion and contraction
- One end of iron girders used in bridges is fixed while the other end rests on the rollers.
- Bimetallic strip is used in thermostats. It is made up of two different metal strips welded or riveted together. It bends due to the uneven expansion of two metals
- Bimetallic strip can be made of Iron and Brass. Brass expands more than the iron strip at the same temperature
- Large bends and coils are used in pipes carrying hot and cold liquids and gases so that they can expand or contract without cracking
- Thermal expansion and contraction are used for different purposes such as riveting, fixing the metal tyre over a wheel and fixing axle into a wheel.
- Water has a peculiar behaviour. It has more density at 4°C whereas less density at 0°C

EXERCISE

1 Write answers of the following questions

- Define thermal expansion. Explain expansion of solids with examples.
- What are the effects of heating and cooling on liquids? Explain with the help of an activity.
- Prove with the help of an experiment that gases expand on heating and contract upon cooling.
- Describe the effects of expansion and contraction of solids. How are these effects overcome?
- How does a bimetallic strip work in thermostat?
- What problems do heat-related expansion cause for bridges or railways?
- Why do telephone wires sag down during summer days?
- Why gaps are left in railway tracks?
- What are the unique freezing properties of water?

2 Choose the correct answer

i) Which of the following does not make use of the expansion and contraction?

a) An electric fan b) An electric iron
c) A railway track d) A thermometer

ii) Which liquid is used in a clinical thermometer?

a) Water b) Oil
c) Mercury d) Vinegar

iii) Which of the following substances expands the most, for the same rise in temperature?

a) Air b) Water
c) Copper d) Glass

iv) Bimetallic strip is used in

a) Electrical Fan b) Tape recorder
c) Electric Iron d) Computer

V) Rivet is used to fasten

a. soft material with hard material

b) soft materia. wi h soft material

c) hard materia. with hard materia.

d) plastic with soft materia.

3. **Give reasons why?**

a Mercury is used in thermometer

b) A bimetallic strip is used in electrical gauges.

c) An iron tyre is heated before fitting it on a wheel

d) Pipes burst when water freezes inside them

PROJECT

Making a Bimetal Fire Alarm

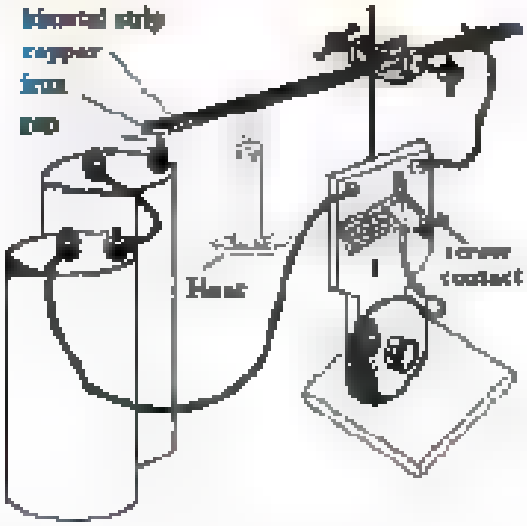


Figure 9.25 Circuit Diagram of Fire Alarm

What I need.

- Insulated copper wire
- Bimetallic strip (Brass and Iron or copper and Iron)
- Iron stand with clamp
- Battery
- Bell
- Candle spirit lamp
- Match box

What to do

- Connect all the given materials one after another in a loop as shown in the Figure 9.25
- Connect all the material as shown in the figure (circuit diagram)
- Light the candle and place it under the free end of bimetallic strip
- Heat will start bending the bimetallic strip gradually and free end of the bimetallic strip will touch terminal of battery. Circuit will be completed and the bell will start ringing.

CHAPTER 10

LENSES

In your previous classes you might have studied about telescope and microscope. Telescope helps to see objects at distance whereas microscope enlarges the objects thousand times of their size. There might be few students in your class who wear glasses to read books and blackboard. Have you ever wondered why this is so? When you see through the microscope or a telescope you might have seen a transparent glass in the eye piece. These are ***Lenses.***

Look at the pictures given below and answer the questions.

- Why are these children using telescope and microscope?
- How a child can see distant objects through telescope?
- How a child can see tiny organisms from the microscope?

In this Chapter you will learn about:

- Lenses
- Types of Lenses (Converging and Diverging Lenses)
- Image Formation by Ray Diagram
- Image Formation in Simple Camera and Human Eye
- Uses of Lenses

All the students will be able to:

- Define lens
- Differentiate between the different types of lenses
- Describe the image formation using a lens by ray diagram
- Compare and contrast the working of a human eye with the lens camera
- Explain how eye focuses by altering the thickness of the eye lens
- Investigate how eyes get used to darkness after some time
- Explain how lenses are used to correct short sightedness and long sightedness
- Identify the types of lenses used for various purposes in daily life

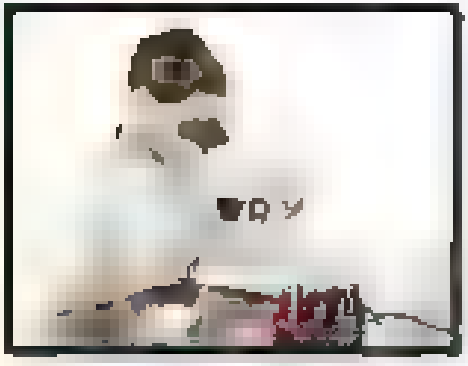


Fig. 10.1 A Child using Microscope

Fig. 10.2 A Child using Telescope

LENSES

- Define lens

A lens is a transparent curved piece of glass or plastic designed to refract light in a specific way. Each surface of lens is a part of a sphere. You must have studied in your previous classes that when a light ray moves from one medium (like air) to another medium (like glass), it bends. This is called refraction. By using refraction lenses can bend multiple light rays. Most of the lenses we use in everyday life are designed to bend light rays to a specific focal point where objects get clearer.

TYPES OF LENSES (CONVERGING AND DIVERGING LENSES)

- Differentiate between the different types of lenses

There are two main types of lenses: Convex (converging lens) and Concave (diverging lens).

1 Convex or Converging Lens

Converging lenses can be identified by their shape: they are relatively thick across their middle and thin at their upper and lower edges. A converging lens is curved outwards on both sides. It causes the light rays to bend to a specific focal point; hence converges rays at a specific point making a real image on screen.

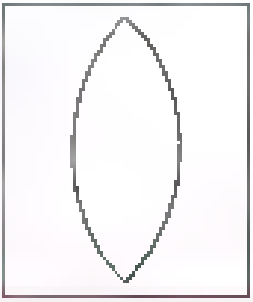


Fig. 9.3 Convex lens

2 Concave or Diverging Lens

Diverging lenses can also be identified by their shape, they are relatively thin across their middle and thick at their upper and lower edges. A diverging lens is curved inwards on both sides. Diverging lenses refract the parallel rays of light so that they spread apart from one another. This means that they form a virtual image; virtual image cannot be projected on a screen.

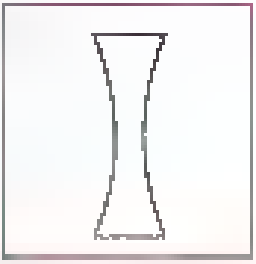


Fig. 9.4 Concave lens

IMAGE FORMATION BY RAY DIAGRAM

- Describe the image formation using a lens by ray diagram

The language of a lens: There are certain terms which we use relative to the lens

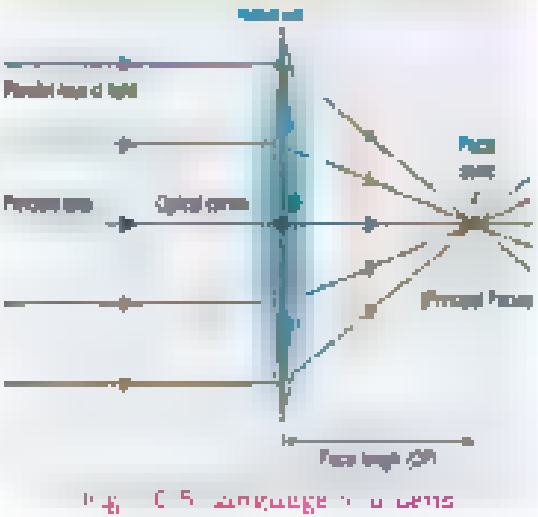


Fig. 6.5 Language of a Lens

1. **Optical Centre** The centre of a lens is called optical centre
2. **Centre of Curvature**. The centre of a sphere is called centre of curvature of which lens is a part
3. **Vertical Axis:** A line that bisects lens into two halves
4. **Principal Axis** The line passes through the optical centre and centre of curvature of the faces of the lens is called principal axis
5. **Principal focus (F) of a Lens.**

- **Convex lens** In case of convex lens the light rays parallel to the principal axis after refraction through the lens meet at a point. This point is called principal focus (F). As the light rays actually meet at the focus point after refraction through the lens, so the focus point is real. Since convex lens converges light rays at principal focus that is why it is called converging lens. Because of this property convex lens makes real images on the screen placed on the other side of the lens
- **Concave lens:** In case of concave lens, light rays parallel to the principal axis after passing through the lens bend in such a way that they do not meet at a one point. They diverge out and appear to be coming from one point which is called principal focus. The principal focus of a concave lens is virtual. That is image cannot be taken on the screen

6. Focal length of a Lens (f)

- **Convex lens** The distance between the optical centre and the principal focus is called focal length (f) Focal length of a concave lens is taken as positive
- **Concave lens:** The distance between the optical centre and the principal focus is called focal length (f) Focal length of a concave lens is taken as negative

Image formation by convex lens using ray diagram.

Following steps should be followed for drawing ray diagram

1. Draw a double convex lens and pass the line that is principal axis through the optical centre of the lens
2. Draw an object to the left side of the lens represented by an arrow
3. Draw one ray parallel to the principal axis and bend it from the centre of the lens passes through the focus
4. Draw another ray from the object passes through the centre of the lens
5. The point at which these rays intersect each other after refraction is the top of the image

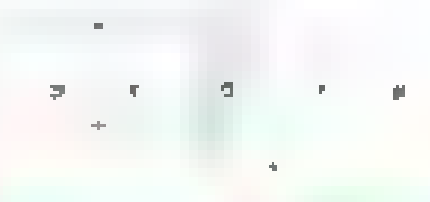
Fig 6.6 Ray Diagram

Image formation by a concave lens using ray diagram.

In case of concave lens rays diverge out and do not meet on the other side of the lens. The image will always be virtual upright and smaller in size and is formed on the same side of the lens on extending the rays backward

1 When the object is at infinity

When the object is at infinity the rays are parallel and strike the lens and get diverged Extend the rays backward and pass them from the focus An erect virtual and diminished image is formed at the focus on the same side as the object



Fig

2. When the object is placed in front of F

Draw a ray parallel to the principal axis and diverge it from the lens. Draw a second ray and pass it from the optical centre. Extend the first ray and pass from the focus. At the point where two rays meet, will the image form. When the object is placed at any position between O and infinity, an erect, virtual and diminished image is formed between O and F.

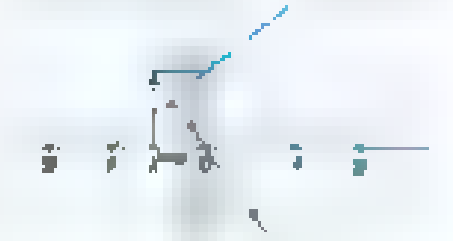


Fig: When object is placed in front of F

Activity 10.1

Image formation by a convex lens

What you need: Magnifying glass, a blank wall outside of your class where you get light

What you do:

1. Stand in front of the blank wall where you get light.
2. Hold a magnifying lens in your hand and try to take image of any distant object on the wall e.g. tree.
3. Move the lens back and forth to take the clearer sharp image.
4. Note down the characteristics of the image in the observation table.

What you observe:

	Size of image: larger or smaller	Nature of image: real/virtual/erect/upside down
When we moved lens towards the object		
When we moved lens away from the object		

Activity questions:

1. Which type of image is formed by the magnifying glass on the wall?
2. Can you do this activity by a concave lens? Explain.

Activity 10.2

Exploring lenses

What you need.

Science notebook, convex lenses, concave lenses, flashlights, white paper and note book

What you do

1. Look closely at the convex lens and note down the surface and shape of the lens in the observation table.
2. Look closely at the concave lens and note down the surface and shape of the lens in the observation table.
3. Look through the convex lens at the pages of your book, your hands, a hair, and other things. Note down how does the convex lens make things look.
4. Now look through the concave lens at the pages of your book, your hands, a hair, and other things. Note down how does the concave lens make things look.
5. Let a flashlight through the convex lens onto a piece of white paper and then note down in which direction does the convex lens bend the light.
6. Let a flashlight through the concave lens on a piece of white paper and then note down in which direction does the concave lens bend the light.
7. Now keep both the lenses in a straight line, faces towards each other and shine a flashlight. Draw pictures of bending of light rays in your science notebook.

What you observe

Lenses	[illegible]	[illegible]	Direction
Convex			
Concave			

Activity questions:

1. How are both lenses alike?
2. How are both lenses different?
3. What happened when you use both lenses at the same time?
4. Can you use both lenses to make distant things appear closer?
5. Which lens converges light rays?
6. Which lens diverges light rays?

IMAGE FORMATION IN SIMPLE CAMERA AND HUMAN EYE

- ✓ Compare and contrast the working of a human eye with the lens camera
- ✓ Explain how eye focuses by altering the thickness of the eye lens
- ✓ Investigate how eyes get used to darkness after some time

Camera

The main parts of the camera involved in the process are the camera body, the camera shutter, the camera lens, the lens aperture, and the camera's image sensor or the film. The camera's LCD screen is for previewing and then viewing the captured image. The camera body is a light proof box. The controls for exposure settings and other effects are located on the camera body. The camera shutter and the image sensor are located inside the camera body. Depending on the type of camera, the camera lens may be permanently attached to the camera (fixed lens) or removable (interchangeable lens). When the button is pressed to release the camera's shutter, it opens and any light flowing into the camera lens is directed through the lens

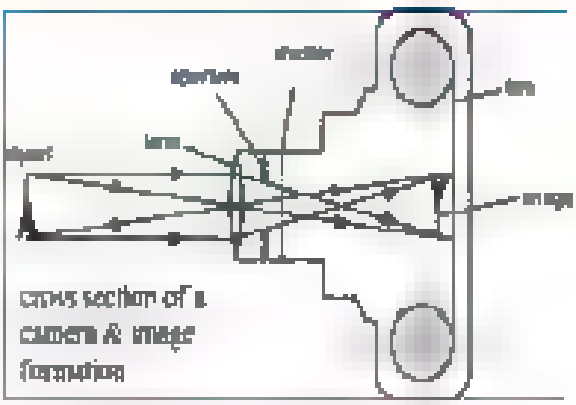


Fig. Image formation in camera

Activity

Make groups of 5-6 students each. Give one convex lens, one concave lens and one flashlight to each group. Assist students wherever required.

aperture and the open shutter to the camera's image sensor. The picture is obtained by developing the image on the film or by getting print from the computer.

Human Eye:

The given figure 10.10 shows different parts of human eye.

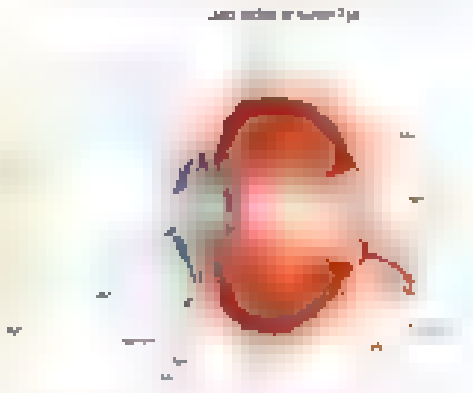


Fig. 10.10: Cross section of a Human Eye

Light from an object passes through the cornea which is a transparent dome like structure covering the iris. The light rays are refracted by the cornea onto the lens. The light rays are refracted second time while passing through the lens and focused onto the retina - the light sensitive part of the eye. The image formed on the retina is inverted (upside down) and real (the light rays travel through the image). The image is interpreted the right way up by the brain which is connected to the eye via the optic nerve.

Camera and Human Eye: Similarities

I) Parts:

a) Cornea of an eye and front lens of the camera

A convex lens is mounted on the front side of a camera. Your cornea behaves much like the front lens of a camera. Together with the lens which is behind the iris, they are the eye's focusing elements. The cornea takes widely diverging rays of light and bends them through the pupil, the round opening in the central portion of the coloured iris.

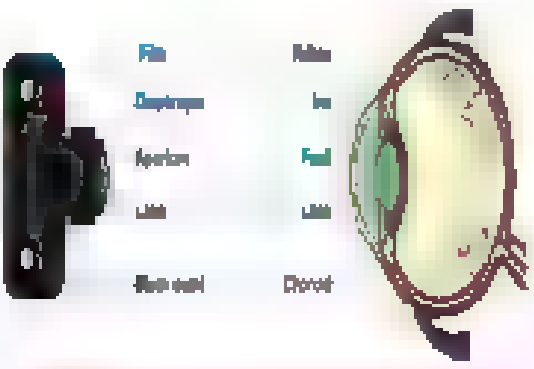


Fig. 10.11: Camera versus Human Eye

b) Iris and pupil of an eye and aperture of a camera

There is an opening in the diaphragm behind the lens which controls the light. Your iris and pupil act like the aperture of a camera. The iris is a muscle which when contracted covers all but a small central portion of the lens allows adjustable control of the quantity of light entering the eye so that the eye can work well in a wide range of viewing conditions, from dim to very bright light.

c) Retina of an eye and film of a camera.

A real and inverted image is formed on the film of a camera. Our Retina is the sensory layer that lines the very back of our eyes. It acts very much like the imaging sensor chip in a digital camera or like a film in a film camera where image is formed. The retina has numerous photoreceptor nerve cells that help change the light rays into electrical impulses and send them through the optic nerve to the brain where an image of what we see is finally received and perceived. Because of this reception and perception function retina is perhaps the most important component of our eyes.

II) Working

1. **Image focusing** Human and camera lenses both focus an inverted image onto a light sensitive surface. In case of a camera it is focused onto film or a sensor chip. In your eyes the light sensitive surface is the retina on the inside of your eyeball.

2. **Light adjustment** Both the eye and a camera can adjust quantity of light entering. In a camera, it is done with the aperture control built behind the lens, while in your eye it is done by having a larger or smaller iris.

Camera and Human Eyes: Differences

Your eyes work in harmony with your brain to create the images you perceive. Your eyes are adjusting the focus by bending the light through the lens in your eyeball as

DO YOU KNOW?

The retina contains about 100 million rods and cones. If you consider each of them as a pixel then the human eye has more than a [illegible] camera.

and translating light into an electrical impulse your brain can process. From there onwards it is all about your brain. It is continuously readjusting its colour balance according to the lighting context. In other words, your eyes know what must be seen as red or white or black etc. In a camera it measures the light that hits a series of sensors, but the sensor and the signals recorded need to be adjusted to suit the color temperature of the light illuminating the scene.

a) Lens focus: In camera, the lens moves closer or further from the film to focus. In your eyes, the lens changes shape to focus. The muscles in your eyes change the actual shape of the lens inside your eyes.

b) Sensitivity to light: A film in a camera is uniformly sensitive to light. The human retina is not. Therefore, with respect to quality of image and capturing power, our eyes have a greater sensitivity in dark locations than a typical camera.

How Eye Focuses Light

The human eye is a sense organ adapted to allow vision by reacting to light. The cornea and the crystalline lens are both important for the eye to focus light.

The crystalline lens and accommodation

The ciliary muscle is a circular ring of muscle that attaches all the way around the lens. This ciliary muscle can change the shape of the crystalline lens by stretching it at the edges. When you are looking at a near object, the lens needs to become more rounded at the central surface to focus the light rays. The eye can alter the shape and

Fig. D. 2 How Eye Focuses Light

curvature of the lens to adjust the degree of refraction. This is called accommodation. It allows light to be focused onto the retina from near or distant objects. Accommodation is achieved by the contraction or relaxation of the ciliary muscles which slacken or stretch the suspensory ligaments. The table summarizes how accommodation works.

Object	Ciliary muscles	Suspensory ligaments	Muscle tension on the lens	Lens shape
Near	Contracted	Slackened	Low	Thick and more curved
Distant	Relaxed	Stretched	High	Thin and less curved

Suppose you are playing a football in a playground in a bright sunny day. After first half you go to the rest room to have some soft drink where the light is turned off. You will notice that you are having difficulty in seeing things but after some time you are able to see little and later you can see things clearly. Similarly, when you go out in the sunlight from a dark room it is very difficult to keep your eyes open. Think why does it take your eyes several minutes to adjust to darkness or bright light? Our eyes are amazingly versatile. We can see perfectly well in a vast variety of light conditions. It is our visual system that is able to adapt to bright sunshine and then to darkness when required. What makes this possible? The answer lies in two distinct parts of the eye - the pupil and the retina.

DO YOU KNOW?

You can only see three colors; red, blue and green. All other colors are created through the combination of these three colors. The light, which is colorless, reflects off objects and is then perceived by the eye.

The pupil

The pupil can expand and contract depending on the amount of light available. The pupillary light reflex controls the diameter of the pupil, when the light intensity is greater, the pupil becomes smaller and allows less light in. When it is dark, it instructs the pupil to become larger to enable more light to enter the retina.

Retina

Retina contains rods and cone cells. Rod cells are responsible for vision in dim light or in darkness. Cone cells are responsible for vision in bright light and coloured vision. Rhodopsin is a chemical found in the rods. When you go in the bright light, it breaks down into two molecules, the retinal and the opsin. When you go back in the darkness or in a very dim light, these two molecules recombine into rhodopsin molecule. The re-combination of two molecules is slow, that is why you can see in the darkness after some time.

DO YOU KNOW?

The retinal used in the eye is derived from vitamin A. If a person's diet is low in vitamin A, there is not enough retinal in the rods and therefore not enough rhodopsin. People who lack vitamin A often suffer from night blindness, they cannot see in the dark.

- ✓ Explain how lenses are used to correct shortsightedness and long sightedness.
- ✓ Identify the types of lenses used for various purposes in daily life.

The shape of the eye is very important in ensuring the objects we see are in focus. A person with normal vision can focus clearly on objects both near and far, this is because light from the object is exactly focused onto the retina at the focal point. However for some people focusing on objects far away or close can result in a blurred image forming. These defects in vision are referred to as long sightedness and shortsightedness.

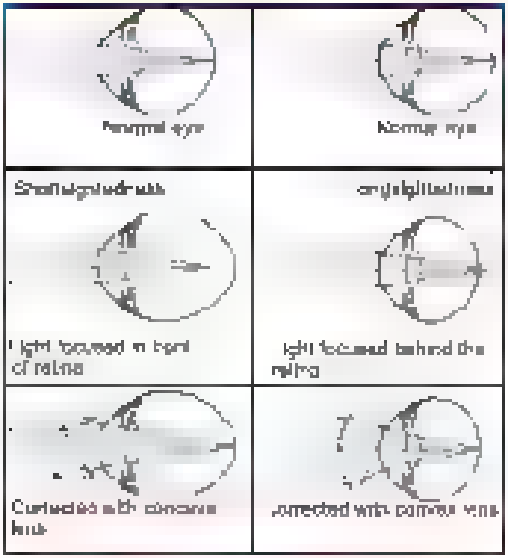


Figure 5.5 Long sightedness & Shortsightedness

Long sightedness

A person who is long sighted can focus clearly on distant objects

but cannot focus on near objects. This is because the eyeball is too short. Light from near objects is focused at a point behind the retina resulting in a blurred image. Fig. 10.13

This defect can be corrected by wearing a convex (converging) spectacle lens. The rays of light from a near object are converged before entering the eye so that the cornea and eye lens can direct the focal point onto the retina.

Short-sightedness

A person who is short sighted can focus clearly on near objects but cannot focus on distant objects. This is because the eyeball is too long. Light from distant objects is focused at a point in front of the retina resulting in a blurred image. This defect can be corrected by wearing a concave (diverging) spectacle lens. The rays of light from a near object are diverged before entering the eye so that the cornea and eye lens can direct the focal point onto the retina.

Lenses exist in a variety of places around us, from the interior of the human eye to the inner workings of computer memory systems. The following are major uses of lenses in daily life:

1. **Magnifying glass:** Convex lens is used as magnifying glasses to magnify objects.
2. **Eye glasses:** Convex lens is used for the correction of long sightedness and concave lens is used for the correction of shortsightedness.
3. **Contact lenses:** A contact lens, or simply contact, is a thin lens placed directly on the surface of the eye. Like eye glasses, contact lenses are put to correct refractive errors.
4. **Different optical instruments:** In binoculars, monocular, telescopes, microscopes, cameras and projectors different types of lenses are used.
5. **Flashlight:** Concave lenses are used in flashlights to magnify the light produced by the bulb. The light falls on the concave side of the lens and the rays diverge on the other side, thereby increasing the apparent radius of the light

source and providing a wider beam

6. **Lasers** Small concave lenses are used in various types of medical equipment, scanners and CD players to widen the laser beams

7 **Peepholes** Door viewers, or peepholes are small security devices that provide a wide view of objects and environments outside doors or walls The view is created using one or more concave lenses inside the device which minimizes the proportions of specific objects and gives a wide overview of an entire area

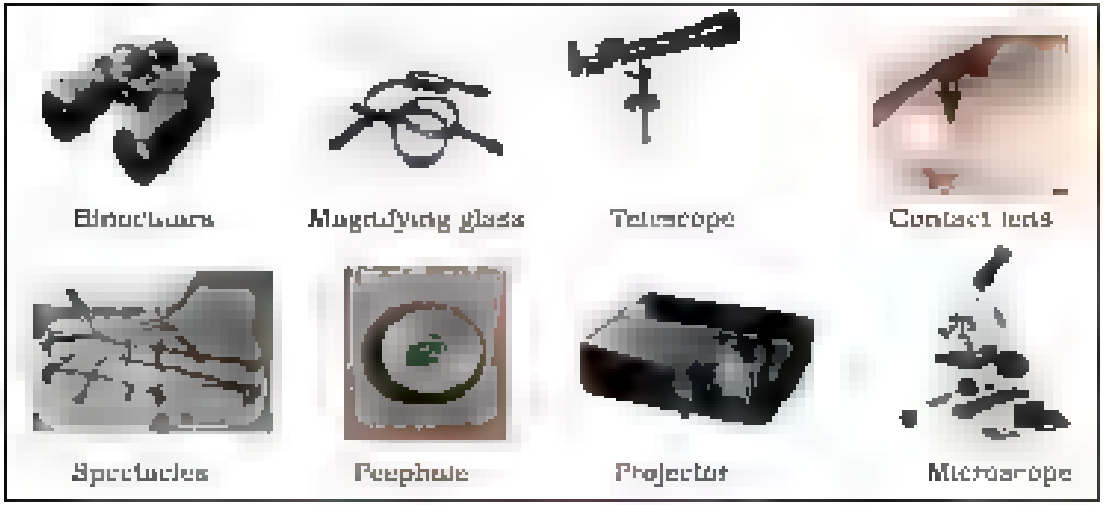


Fig 10 14 Uses of lenses

SUMMARY

- A lens is an optic piece of curved transparent glass that refracts light in a specific way
- There are two types of lenses convex and concave
- Convex lens converges light whereas concave lens diverges light
- A converging lens is thicker at the middle than its edges whereas a diverging lens is thinner at the centre than its edges.
- The centre of the lens is called optical centre
- The distance between the optical centre and principal focus is called focal length
- There are certain terms which we use relative to the lens i e optical center, principal axis, principal focus, focal length, vertical axis.
- Concave lens always forms virtual images
- There are certain parts of human eye that work like camera Like cornea and lens aperture lens pupil, retina work like lens aperture and film of a camera
- Eye focuses by altering the thickness of the eye lens More curved for the nearer objects thinner for the far objects Ciliary muscles and suspensory ligaments help in this action
- In long sightedness image is formed at the back of the retina and it is treated by convex lens
- In shortsightedness image is formed in front of the retina and it is treated by concave lens.
- Magnifying glass microscope, telescope, projector vision spectacles are some major uses of lenses

EXERCISE

1 Choose the correct answer

i. A horizontal line that passes through the lens is called
   a) vertical axis b) principal axis
   c) optical centre d) focal point

ii. The point through which a ray of light passes without changing its path is the
   a) centre of curvature b) mid point of F and O
   c) principal focus d) optical centre

iii. To obtain sharp image in a camera
   a) lens is moved back & forth
   b) film is moved back & forth
   c) both the lens and the film are moved
   d) neither lens nor film are moved

iv. Which of the following helps to change the shape of the lens in the eye?
   a) Ciliary muscle b) Cornea
   c) Retina d) Iris

v. The distance between the optical centre and the principal focus is called
   a) principle axis b) vertical axis
   c) focal length d) optical centre

2. Fill in the blanks.

When the object is at infinity, the rays are parallel and strike the _____ lens and get diverged

i. An erect and diminished image is formed when the object is placed in front of _____ of concave lens

ii. A _____ lens is used as a magnifying glass

iii. Light from near objects is focused at a point behind the retina in the eye. hence creates defect called

iv. In the eye defect shortsightedness, the eyeball is too _____ and the light from the distant object is focused _____ of the retina

3. **Complete the given table.**

S No:	Parts of a camera	Similar part of an eye	Similar function
1	Aperture		
2	Lens		
3.	Film or image sensor		

4 **Answer the following questions**

Describe the formation of ray diagram by convex lens

ii Why an image can not be formed on the screen by a concave lens? Explain.

iii How is the focal length of a lens affected by its thickness?

iv Draw a ray diagram for long-sightedness

v Which type of lens do you have in your eye?

vi Write THREE differences between long-sightedness and short sightedness

5. **Write similarities and differences of convex and concave lenses in the given Venn diagram.**

CHAPTER

11 ELECTRICITY IN ACTION

As you have studied in the previous classes, electricity is a form of energy that can be generated when electrons or electric charges flow through a conductor like a copper wire. Electrical energy can be natural as lightning in sky or can be produced by a generator. Do you know that electricity can be used to make magnets? In the same way the opposite operation can be performed that is magnets can be used to produce electricity.

In this Chapter you will learn about

- Generating Electricity (Model Generator)
- Portable Generator (Bicycle Dynamo)
- Problem of Generating Electricity
- Working of Power Stations
- Other Sources of Electricity
- Introduction to Electronic Systems
- Uses of Components: Input, Processor, Output

All the students will be able to:

- Design an experiment to generate electricity
- Explain the working of the model generator
- Identify the simple devices that generate electricity in daily life
- Design and demonstrate the working of a power station
- List type of energy being used in power stations
- Relate problems involved in generating electricity
- Describe basic component of an electronic system.
- Explain A.C and D.C current
- List component that would be needed to turn A.C to D.C
- State how output components in various devices could be used in their schools and surroundings

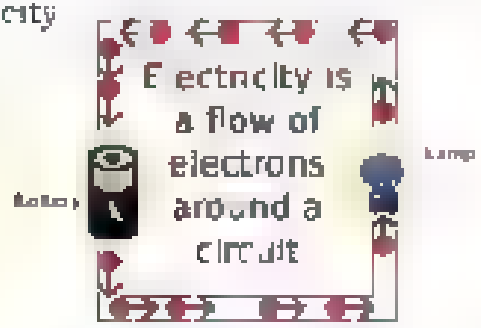


Fig. Electric Current

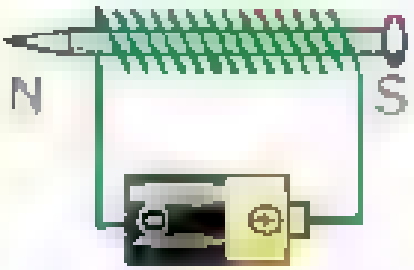


Fig. Simple Demonstration

Fig. Power Station

GENERATING ELECTRICITY

- Design an experiment to generate electricity

In our homes all electrical appliances use electricity and without it they cannot work. There are many methods and sources which can be used to generate electricity. For example, dry cells and batteries produce electricity by chemical reaction of compounds.

Activity 11.1

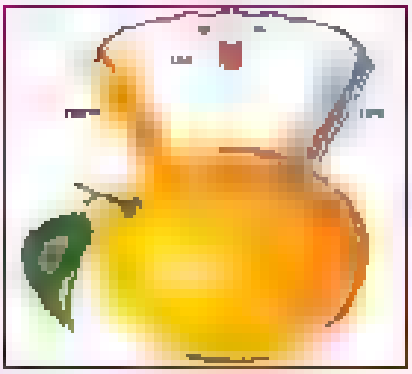
Electricity Generating Model

What I need

Copper metal piece, zinc metal piece, a lemon, LED

What I do

Take two pieces of copper and zinc metals, insert the one end of both metals pieces into a lemon at two different places as shown in figure. Connect the other end of both zinc and copper with two wires to the terminals of an LED.



Lemon battery

What I observed

I observed that LED is lighting up. The lemon produces very small current of about one milli-ampere. This current is however very small to light up a resistance bulb.

Activity Questions

How LED lights up?

How much current is produced by the lemon?

Teacher's Note

Divide the class into two groups. Ask two students from each group to perform the activity. Rest of the students will observe the activity and will take notes. Provide one set to each pair. Ask students to perform activity shown in figure. Also perform this activity with potato and vinegar. Promote discussion on phenomenon.

ELECTRICITY GENERATOR MODEL

- Explain the working of the model generator

We have studied above that electricity can be produced by chemical methods. Similarly we can alsogenerate electricity through mechanical ways for example moving magnet through a coil or a coil through a magnet.

For this we need to have a "J" shaped magnet and a wire with some loops called a coil. When magnet moves around the coil, the magnetic field passes through the coil and as a result, some current passes in the coil. Both ends of the coil should be attached with some electrical appliance like a bulb, LED or a battery. As the current flow changes its direction with an equal interval of time and therefore, this current is called Alternating Current (AC).

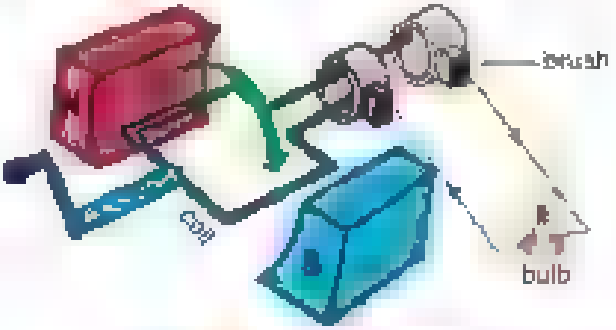


Fig 4 Electricity generator Model

PORTABLE GENERATOR (BICYCLE DYNAMO)

- Identify the simple devices that generate electricity in daily life

Do you have a bicycle? If yes, then you may light a lamp to mount on it without any battery source. Do you want to know how? Let's learn.

As we know that the moving magnet through the coil can produce some amount of energy to be used for electrical appliances. here we use the same. The small generator called the bicycle dynamo is the device that can produce electric current and light up the lamp that is mounted on it.


Fig 5 Bicycle Dynamo

The magnet inside the dynamo spins by the tyre of bicycle. As the tyre starts to rotate magnet spins through coil then coil starts to generate some amount of current through it. The coil end that passes attached to the lamp mounted on the bicycle. Harder you paddle the bicycle the faster the dynamo spins. As faster it spins more electricity the dynamo produces hence bulb becomes brighter.

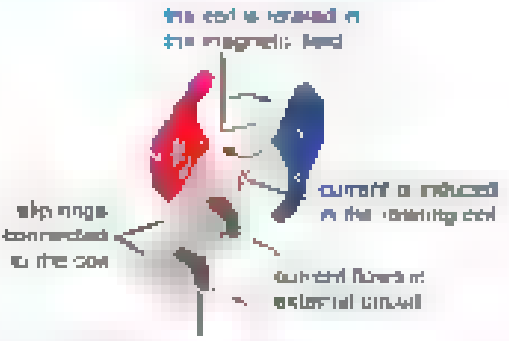


Fig. A working view of Bicycle Dynamo Generator

WORKING OF POWER STATION

✓ Design and demonstrate the working of a power station

A country requires more electricity for commercial as well as domestic use. We use power station generators for this purpose which are bigger than bicycle dynamo generator and produce electricity in a large amount to be used in homes and offices. As the dynamo has few turns of coil in it and has permanent magnet, the same way power station generator has many coils with large numbers of turns in each coil. These coils can be used for producing magnetic field instead permanent magnet. There is one stationary coil that stays at a point whereas the other coil is rotational that spins at steady rate with the help of mechanical force that helps to keep it revolving and to produce current and voltage. These mechanical forces can be provided by water, steam and fuel like diesel, coal and gas which helps to rotate the coil through magnetic stationary coil. Power station generators produce very large current and high voltage.

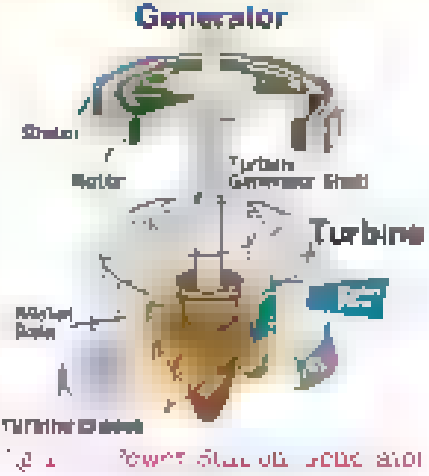


Fig. Power station generation

OTHER SOURCES OF ELECTRICITY

- List types of energy being used in power stations

There are many sources other than mechanical generators to produce electricity. Some sources that are being most often used for producing electricity are solar energy, wind energy, nuclear energy and biomass, moving water energy and heat energy.

➢ Solar Energy

Solar panels contain solar cells which are called photo-voltaic cells. The solar powered calculator uses these cells for absorbing sunlight energy and converting into electrical energy to charge the battery or to use it directly. Good thing about solar panels is that they do not pollute the air and environment. In Pakistan, a solar power plant has been installed and named as Quaid-e Azam solar power plant. One of the draw backs of solar power is that it produces little electricity when sun is behind the clouds and it does not produce any electricity during night time. However, these can be used to recharge or stock electricity in batteries to have an un interrupted power supply to our homes during night hours. Today, solar panel installations in schools are becoming more popular as it decreases the environmental impact of these institutions and making them greener and more eco-friendly.

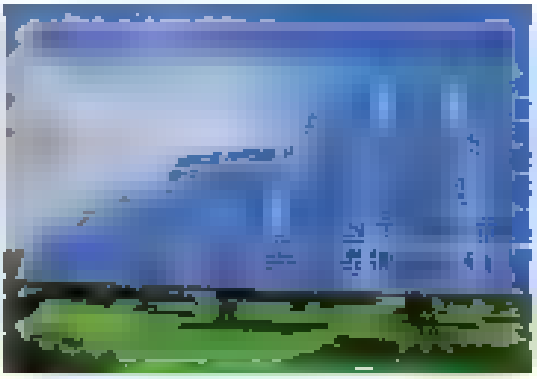


Fig. 1.8 Solar Energy Power Plant

➢ Wind Energy

Wind energy is a form of energy which can be used to generate electricity by wind or supply by air pressure. Wind produces the kinetic energy which is used to rotate the blades of fan of wind

energy system. The axil of fan therefore rotates generator to produce electricity. These wind energy systems can be seen on lands which is windy enough to rotate the fan or blades of wind energy system. You can see hundreds of wind energy power stations around Noorabad area while traveling from Hyderabad to Karachi.

Fig. 1.7 Wind Farm Energy Power Plant

➢ Nuclear energy

Nuclear energy is a form of energy which can be found in the nucleus of an atom of an element. When nuclei of heavy elements are broken into lighter nuclei by a special process called fission a large amount of heat energy is released. This heat makes steam and is used to rotate the turbinewhich runs the electric generator to produce electricity.

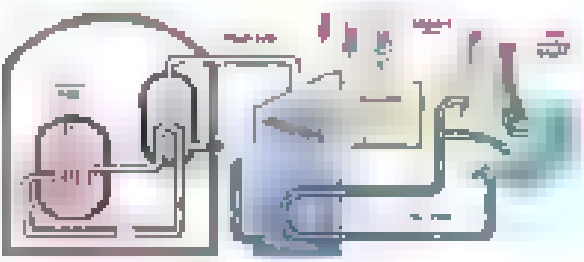


Fig. 1.8 Nuclear Energy Plant

➢ Biomass

Biomass is the oldest sources of energy which is obtained from

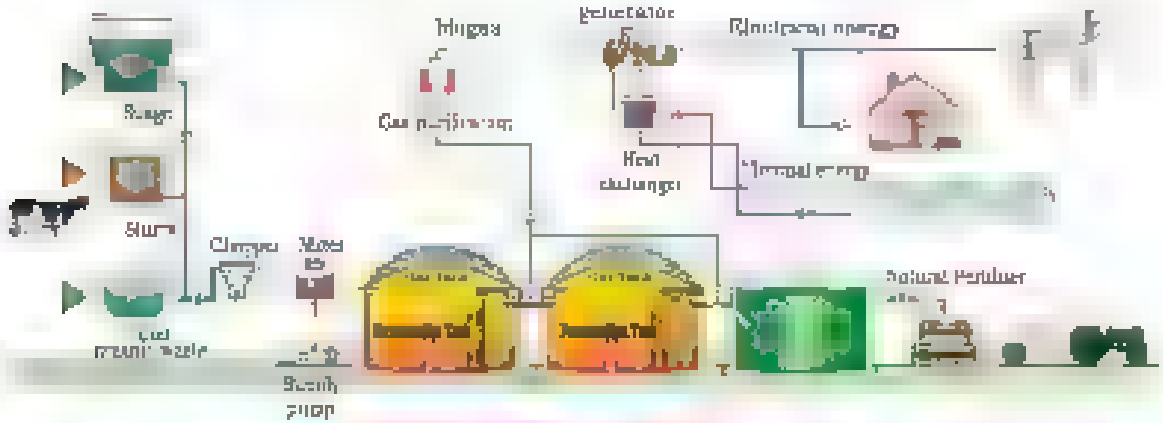


Fig. 1.9 Biomass Energy Plant

animal waste and fossils plant material It is used as a fuel to produce heat energy The steam then produces kinetic energy in the turbine of biomass and rotate the generators to produce electricity It is economical way to produce electricity by using biomass

➢ Hydro-electricity Energy

Hydroelectricity is the kind of electricity generated by power of falling or flowing water The most common type of hydroelectric power plant uses a dam on a river to store water in a reservoir Water released from the reservoir flows through a turbine, which converts the kinetic energy of falling water into mechanical energy Then a generator converts the mechanical energy from the turbine into electrical energy

➢ Thermal Energy

Thermal energy is produced from heat It uses the gas wood coal and petroleum to produce heat This heat is used to generate a pressure in combustion chamber of generator from which a turbine is operated and moves to generate the electricity

PROBLEMS OFGENERATING ELECTRICITY

✓ Related problems involved in generating electricity

There are many problems involved in generation of electricity Some of these are given below

1 Electricity can be produced by using flow of water Its running cost is though very low, but the construction of dams is very expensive Also, the water causes logging in nearby areas and makes the land weak for the agricultural use Further, in case if there is no raining there can be water shortage which ultimately causes problem in generating electricity

2 The nuclear energy is also the source of producing large amount of energy, but it can be very dangerous because of the use of radioactive elements producing radiations and hence, can harm the lives for the years

3 Thermal energy is a good source of energy but we need fuel to make heat energy that can be used to run the turbine. The prices of fuels are going very high and that is why this method is very expensive to produce electricity. Also these fuels when burn make smoke and hence pollute the atmosphere.

4 The sources which produce renewable energy are also expensive to install. Their plants like solar energy and wind energy plants are much costly as they produce little amount of electricity.

5 When power is transmitted for homes and commercial areas the magnetic field around transmission lines may cause hazards for the human health.

6 High voltage shock is harmful. Accidental contact with high light voltage lines can cause harm or death to human and other animals.

INTRODUCTION TO ELECTRONIC SYSTEMS

- ✓ Describe basic component of an electronic system.
- ✓ Explain A.C and D.C current.
- ✓ List components that would be needed to turn A.C to D.C.

Electronics is a branch of physics that deals with controlling of electrical energy. The fundamental role in electronics is of electrons. In our daily life we use lots of electronic devices like, Television, Mobile Phone, Computer, Camera, Radio, Video games, DVD player etc. In this modern era, we have a very advanced electronics appliances that make our life easy and luxurious. Now a day we have a package of all necessary things in a single set of mobile phone, for example a telephone, a camera, a watch, a television, a computer and many more applications.

Fig 1.12 Various Electronic Devices

Alternating Current (AC)

Alternating current is defined as the flow of charge that changes direction periodically. The voltage level also reverses along with the current. Basically AC is used to deliver high power to industries, buildings, etc.

Direct Current (DC)

The current, which flows in one direction is called Direct current (DC). DC is referred to voltage whose polarity never reverses. It has two conductors with polarity of positive and negative charges.

Conversion of AC to DC (Rectification)

A rectifier is a simple diode or group of diodes which converts alternating current (AC) to direct current (DC). The process is known as rectification. We know that a diode allows electric current in one direction and blocks electric current in another direction. This principle is used in rectification. A half wave rectifier is a type of rectifier which allows only half cycle of the input AC signal while the half cycle is blocked. In this way it converts AC to pulsating DC.

Basic Components of an Electronic System

The basic components that are used in electronics are Resistor, Diode, Transistor, integrated circuit (IC). These are most commonly used components and are the basic building blocks for electronic circuits.

1 Resistor

Resistor is a device that opposes the flow of electrons in electronic circuits. It is a two terminal device that can be used to reduce the electric current in electronic circuits. The unit of resistance is Ohm and its symbol is (Ω)

Fig. 15 Resistor

2. Diode

It is made up of a material that is called semiconductor. Semiconductor is the element which acts sometime as conductor and sometime as insulator depending on certain conditions. Diode can be used for different applications like electronics switch, reverse current protector and Alternate current to Direct current conversion. It has different types like LED (Light Emitting Diode) is a diode which gives out the light rays or light beam when an electric current flow through it. This is the same LED which we are using now a days at home for lightings to save our electricity. As compared to normal bulb, LED consumes lesser electricity and therefore saves the energy. They are also used in displaying numbers and letters in digital equipment such as calculators, digital clocks, digital meters and many others.

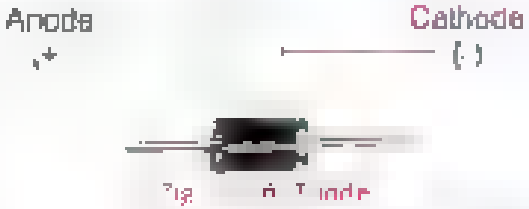


Fig. 16 Diode

3. Transistor

In electronics transistor is the most important device. A transistor is the device which controls the flow of electricity or simply electrons by acting as a switch that can be turn on and off electronically. It can also be very small that a human eye cannot see. Millions of tiny transistors can be combined into a small device which is called integrated circuit. This can make system more compact and small in size and therefore can be used very fast.

Fig. 17 Transistors

USES OF COMPONENTS(INPUT, PROCESSOR, OUTPUT)

- ✓ State how output component in various devices could be used in the schools and surroundings

Electronic devices commonly used in our daily life are of three major types according to our requirements, these are given as follow

1 Input Devices

A device or component that provides information in different forms of energy converts it to electrical signal and then forwards it to the computer is called input device There are many types of input devices that can be used for providing input or instruction or information to the other device for example the digital camera which takes photo of physical object and converts it to the electrical signal same with the scanner Keyboard and mouse of a computer are also the input devices which can be used for providing information or the instruction to the computer so that a computer can perform a particular task Microphone is another example of input device that can be used to convert the voice into electrical signal

Fig 8 Input Devices

2 Processor

Fig. ... computer containing processor

It is a component that functions as the brain of a computer or electronic system. In computer, Central Processing Unit (CPU) contains the Processor which performs typical tasks of processing of a computer program and carrying out computer operations. It basically converts the input to the desired output in some calculated way. Your smart phone also has processor which provides the output on screen while having some input in numeric form or through touch screen.

3. Output Devices

An output device is a device that is used to receive the data from processor and shows its results of giving input and processing through processor. For example, when we give input through microphone it converts our voice into electrical signal and acts as processor. Finally we listen our voice amplified through the speaker which is an output device. Your computer has a monitor, which is also an output device. Smart phone screen and television screen are output devices too. Also computer monitor, printer, loudspeaker, electric bell and telephone receiver are well known output devices commonly used in schools, homes and offices.

Fig. ... 20: Output Devices

SUMMARY

1. Electricity is a form of energy produced when electric charges flow through a conductor
2. Electricity can be generated by moving a magnet through a coil or a coil through a magnet
3. Power Plant generators are used to generate large amount of electricity to fulfil the domestic and commercial needs of a country
4. There are some sources which most often use for producing electricity at low cost like solar energy,wind energy nuclear energy and biomass energy systems
5. Electronics is a branch of physics that deals with controlling of electrical energy. The fundamental role in electronics is of electrons
6. Resistor, Diode, Transistor, integrated circuit (IC) are most commonly used components of electronic circuits
7. Diode is a device that passes the electric current in one direction and blocks current flow in reverse direction
8. A transistor is the device which controls the flow of electricity or simply electrons by acting as a switch that can be turned on and off electronically
9. A device or component that provides information in different forms of energy, converts it to electrical signal, and forwards it to computer is called input device
10. An output device is a device that is used to receive the data from processor and shows its results

EXERCISE

Q 1 Choose the correct answer

i Which part of a bicycle dynamo spins to generate electricity?
(a) Tyre (b) magnet (c) coil (d) galvanometer

ii The electricity from a cell is called
(a) Direct current (b) Indirect current
(c) Alternating current (d) High current

iii The electricity we use in our homes and schools is called
(a) Low current (b) Indirect current
(c) Alternating current (d) direct current

iv Which of the following is NOT a renewable energy source?
(a) Windpower (b) geothermal energy
(c) tidal power (d) natural gas

v The electronic device which is used as a switch or amplifier is called a
(a) Transistor (b) thermostat
(c) thermistor (d) transformer

vi IC stands for
(a) inner chip (b) integrated chip
(c) integrated circuit (d) input circuit

vii Silicon is an example of
(a) Insulator (b) conductor
(c) semi-conductor (d) semi-insulator

viii Barcode reader is an
(a) Output device (b) input device
(c) amplifier (d) insulator

ix Flow of electrons is called
(a) Electrodes (b) resistance
(c) electrolyte (d) electric current

x When animals and plants are decayed in absence of air, there produces a gas called
(a) oxygen (b) bio gas
(c) carbon dioxide (d) methane

Q 2 The stages involved in producing electricity in a power station are given below in a jumbled form. Write the letters of the stages in correct sequence in the provided space below

(A) The steam turns the turbines

(B) The electricity is generated and fed to the National Grid

(C) Fuel is burnt and heats the tanks of water

(D) The turbines turn the generators

(E) The water changes to high pressure steam

Q 3 Generation of electricity by wind turbines is considered very costly

Complete the box below by naming the main energy changes in a wind turbine

Energy in the wind
Energy in the moving rotor blades
Output energy from the turbine

Q 4 Why biofuels are considered as economical source of energy?

Q 5 What are the basic building blocks for electronic circuits

Q 6 What are the problems involved in producing electricity by

(a) Nuclear power generator (b) Thermal power generator

Q 7 What are the input and output devices? Give some examples

Q 8 Differentiate between Alternating Current and Direct Current

Q 9 What are the advantages of Solar Power Plants

PROJECT

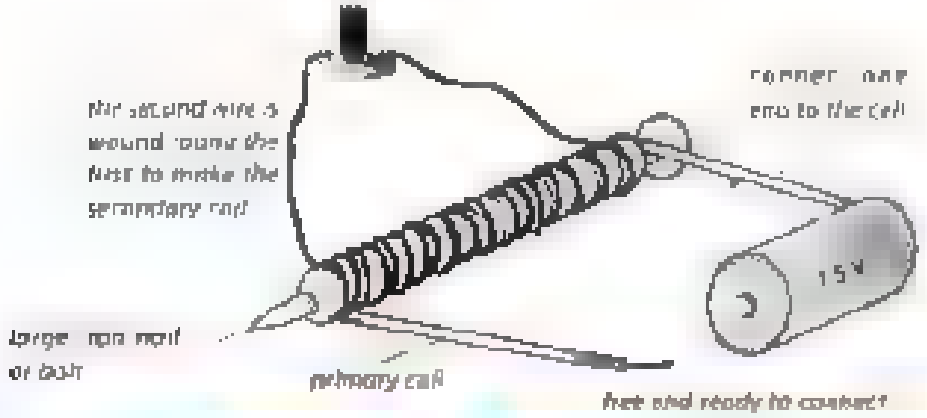
Making a Simple Transformer

Materials needed:

About 1.5 m of thin single core insulated wire, a long iron nail or bolt, a 1.5 V cell, sticky tape, 2.5 V bulb in a holder, small screwdriver

Steps:

1. Cut the wire into two pieces (approximately 0.5 m and 1.0 m in length)
2. Bare the both ends of the wires
3. Wind the shorter of the two wires around the nail fifty turns, (leaving the bared ends free (see diagram below). This is your primary coil.
4. Attach one end of the primary coil to the cell with some sticky tape.
5. Now wrap the second wire around the nail over the top of the first wire) fifty turns. This is the secondary coil.
6. Attach the two ends of the secondary coil to the bulb holder.
7. Touch (on and off rapidly) the remaining free wire of the primary coil to the free terminal of the cell. What happens?
8. Try again but use seventy-five turns in the secondary coil.
9. Now try other combinations of turns.



CHAPTER 12

EXPLORING SPACE

Prior to the recent scientific developments in the field of space science and technology, ground-based telescopes, spectroscopes and other viewing devices were used to observe the sky and other objects. The Sputnik I was the first man-made spacecraft which was launched by the Soviet Union on October 4 [illegible]. With this, began the era of human space exploration where in the human beings not only traveled into space, landed on the Moon but also returned safely. Today, the space exploration provides us numerous benefits such as better understanding of the [illegible] technological growth and other advantages associated with it. In this chapter, we will study how space exploration has changed our daily lives.

- Telescope, Spectroscope, Spacecrafts
- Space exploration

All the students will be able to:

- ✓ Describe development of tools and technologies used in space exploration
- ✓ Analyse the benefits generated by the technology of space exploration
- ✓ Explain how do astronauts survive and research in space
- ✓ Suggest ways to solve the problems that have resulted from space exploration
- ✓ Identify the technological tools used in space exploration
- ✓ Identify new technologies used on earth that have developed as a result of the development of space technology
- ✓ Design a space craft and explain the key features of design to show its suitability as a space craft

Telescope, Spectroscope and Spacecrafts

- ✓ Describe the development of tools and technologies used in space exploration

Telescope

The word "telescope" is a combination of two Greek words. "Tele" which means distant or away and "scope" which means to see. Therefore **telescope** can be defined as an instrument that enables us to see distant objects. Galileo Galilei, an Italian astronomer in the seventeenth century observed Jupiter and its four moons (i.e. Io, Europa, Ganymede and Callisto), Saturn and Venus with the help of a telescope first time in the human history.

Types of Telescope:

There are two types of a telescope (i) Refracting Telescope (ii) Reflecting Telescope

Refracting Telescope:

A telescope that uses lenses is called a **Refracting Telescope**. There are two lenses in a Refracting Telescope one is called Primary or Objective Lens, whose diameter is large while the other is called Secondary or Eyepiece Lens whose diameter is small. It consists of two tubes that slide into each other. Both the lenses are placed at the outer edges of the tubes. The primary lens focuses on the incoming rays of light that create an image. We see this image with the help of Secondary or Eyepiece Lens. Figure 12.1 shows the ray diagram of a Refracting Telescope

Figure 12.1: Ray diagram of a Refracting Telescope

Reflecting Telescope:

A telescope that uses mirrors is called a Reflecting Telescope. There are two mirrors in a Reflecting Telescope one is called Primary or Objective Mirror whose diameter is large and the other is called Secondary Mirror whose diameter is small. A Reflecting Telescope comprises a single tube in which the Objective Mirror is placed at the rear end of the tube. It reflects the rays of light on the secondary mirror which re-directs them towards eyepiece where an image can be seen. Figure 12.2 shows the ray diagram of a Reflecting Telescope

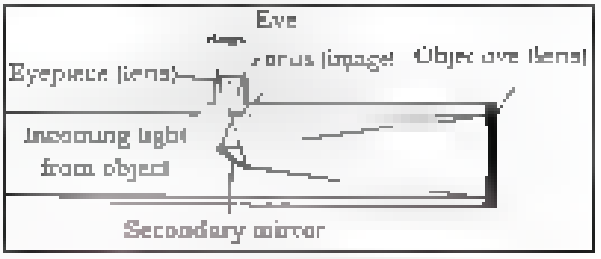


Figure 12.2: Ray diagram of a Reflecting Telescope

Telescopes have not only helped us in better understanding the astronomical objects in the sky but also expanded the horizon of Universe for further exploration and research. They also facilitate us

in discovering new objects in the space every now and then. Today a large number of telescopes have been installed in different countries of the world, while, at the same time, many other have also been sent into space. Currently the Hubble Space Telescope (HST) is one of the most famous telescope launched in space. It is a Reflecting Telescope that has been sent into space as a joint venture of the US and European countries. Orbiting at an altitude of 600 kilometers from Earth, this telescope has provided us many invaluable images of different galaxies, clusters of stars, nebulae, etc.

Spectroscope:

A **spectroscope** is an optical instrument which is used to measure the properties of visible light. It splits white light into its seven different component colours such as Violet, Indigo, Blue, Green, Yellow, Orange, and Red that are arranged according to their wavelengths in the spectrum of light. The set of colours obtained in this way is called a spectrum of light. From Figure 2.3, we can see that Red colour has the largest wavelength whereas Violet has the smallest.

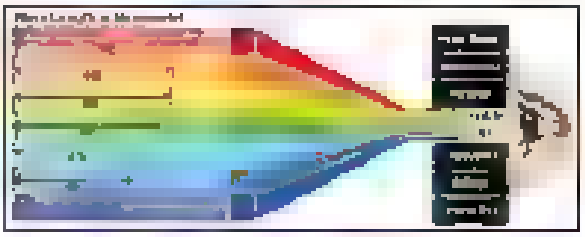


Figure 2.3 Spectrum of white light and its wavelength distribution

The construction and working of a Spectroscope (see Figure 2.4) is shown as follows:

- **Opaque Barrier with a Slit**: It forms a narrow beam of light.
- **Prism**: It splits the narrow beam of light into its seven component colours.
- **Detector or a Screen**: It allows the user to view the resulting spectrum of light.

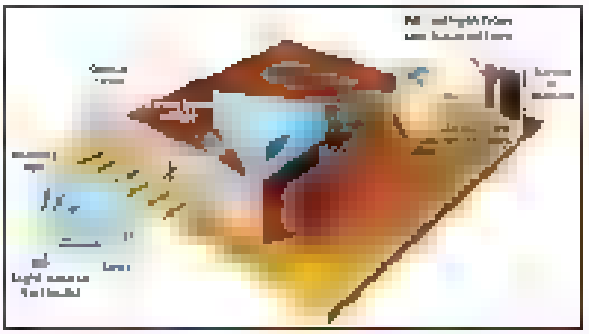
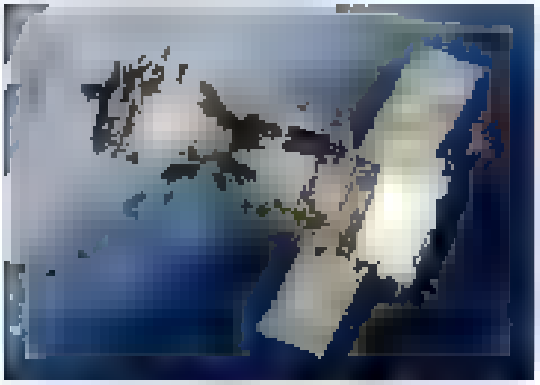


Figure 2.4 Main parts of a Spectroscope and their working

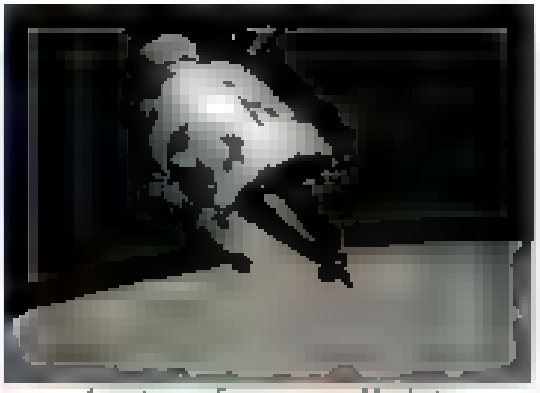
A Spectroscope is attached with a telescope to create a spectrum of light coming from a star. They are used in identifying Chemical Elements in a stellar atmosphere such as carbon, nitrogen, oxygen, etc. Thus, a spectroscope can tell us what elements are present in a star.

Spacecraft:

We use spacecraft for global navigation and communication, monitoring of weather, exploration of planets and other heavenly bodies. A **spacecraft** is a vehicle sent into space to carry out a specific task. A spacecraft can be a manned mission to transport humans and cargo into space and back to earth. It can also be an artificial satellite or a space probe commonly called unmanned spacecraft that is sent into space to gather precise data. Examples of manned spacecrafts are space shuttles namely Soyuz, International Space Station (ISS) and Apollo 17 Command Module that took humans to the Moon (see Figure 12.5).



Soyuz Space craft



Apollo Command Module

International Space Station (ISS)

Figure 12.5 Examples of manned spacecrafts

The Hubble Space Telescope, Venera 9 and Opportunity Rover are some of the examples of un-manned spacecrafts.

Venera-9

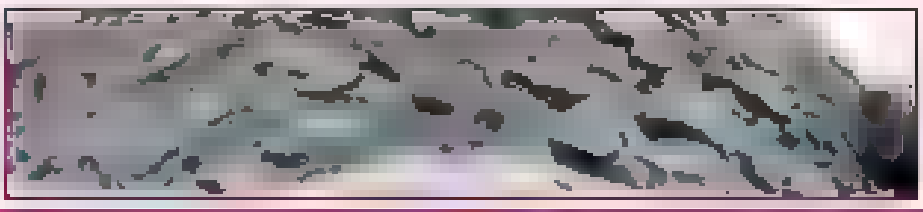
Opportunity Rover on the surface of Mars

Hubble Space Telescope (HST)

Figure 2.6: Examples of un-manned spacecrafts

DO YOU KNOW?

Venera-9 was the first spacecraft landed on surface of Venus. It was launched by Soviet Union in 1975. It became the first spacecraft to go into orbit around Venus



Space Exploration

- ✓ Analyse the benefits generated by the technology of space exploration
- ✓ [illegible] new technologies used on earth that have developed as a result of the development of space technology

Use of astronomy and space technology to explore space is called space exploration. Humans have always been curious about the night sky and outer space. With the passage of time, the [illegible] of human nature and technological developments have enabled human beings to explore it physically by using manned and unmanned spacecrafts. It is hoped that more space explorations will pave a way for managing space in order to ensure the survival of the human race beyond this planet.

Benefits of Space Exploration

More than fifty years of space exploration has provided numerous benefits which have left a far-reaching impact on the daily life of the people living on Earth. The benefits of space exploration can be categorised as either direct or indirect benefits. The direct benefits of exploration include the generation of scientific knowledge, the [illegible] of [illegible] and [illegible] of instruments, patents, robots, etc. Indirect benefits include significant improvement in the quality of life such as economic prosperity, health, safety and security. A few of them are discussed as follows:

1 Health and Medicines

- **Magnetic Resonance Imaging (MRI) and Computed Tomography (CT) or Computerised Axial Tomography (CAT) Scans.** These are digital image processing procedures that are used to obtain images of [illegible] and human body, e.g. human brain. These methods were previously designed to enhance the pictures of the surface of the Moon.
- **Left Ventricular Assist Device (LVAD)** is an artificial heart pump designed basically in the space shuttle's air pumps. It is used as an intermediate measure to keep the heart patients alive before they undergo heart transplant operations or the long term.
- **Breast Biopsy System** is an image guide needle developed by using [illegible] technology used in the Hubble Space Telescope. It is used to obtain a sample from the abnormal development in the human breast for further laboratory tests.

- **Polyurethane Foam** It is a foam like material used to protect and insulate the external fuel tanks of the space shuttle. This foam is used to prepare less expensive molds for its use in the preparation and designing of artificial arms and legs for disabled and handicapped people
- **Cooling Suits** Liquid Cooling and Ventilation Garment technology is used in space suit to maintain a comfortable core body temperature of the astronauts during Extra Vehicular Activity (EVA). Basing on this technology Cooling Suits are designed as a wearable garment to protect a patient's brain and other vital organs following a cardiac arrest.
- **Voice-Controlled Wheelchairs** It's a voice-controlled wheelchair that is used for physically disabled people who cannot control the movements of their hands. It is designed basing on the tele-operator and robot technology used in the space programmes
- **Light-emitting Diodes (LED)** It's a special lighting technology which has been developed for space based commercial plants growth on NASA's space shuttle. This technology is used to treat patients suffering from brain cancer
- **Cataract Surgery Tool** It's a tiny cutter pump designed by NASA as a part of its space technology. It is used to treat the eye patients suffering from the cataract disease

2. Global Positioning System.

Global Positioning System (GPS) is a scientific method, which monitors the movement of vehicles, ships and aircrafts. It determines their location, route and distance travelled from one place to the other. It also provides real time position information of the moving or static objects in all weathers across the globe.

Figure 12.7 Artistic view of [illegible]

The GPS consists of 24 or more satellites orbiting the Earth in the Medium Earth Orbit (MEO) that ranges from a few hundred miles to a few thousand miles above the surface of Earth. A GPS receiver on Earth receives signals from satellites and calculates its absolute

position on Earth. Each satellite makes two complete orbits in 24 hours in such a way that at any time and anywhere on Earth, at least four satellites are always visible in the sky.

DO YOU KNOW?

What is wavelength?

Wavelength is defined as the distance between two consecutive upper peaks also called crests or lower peaks also called troughs of a wave. If crests or troughs are closer then the wavelength will be smaller or vice versa.

3. Weather Prediction/Forecast.

Weather forecasting means predicting or guessing about weather likely to happen in the near future by using different Weather Satellites. Scientists commonly known as Meteorologists do weather forecasting by continuously tracking and predicting the path of tornadoes, hurricanes, or floods. They take pictures of the Earth from space to carefully monitor weather conditions at any location around the world. Meteorologists warn us to seek shelter from dangerous and extreme weather conditions or hazards.

Figure 2.8: A Weather Satellite

4. Remote sensing of Earth

Remote sensing is the science of obtaining information about objects or areas on Earth from space by using satellites. They are used for better understanding of the phenomenon taking place on the surface of Earth. Images taken from Remote Sensing Satellites facilitate the scientists and

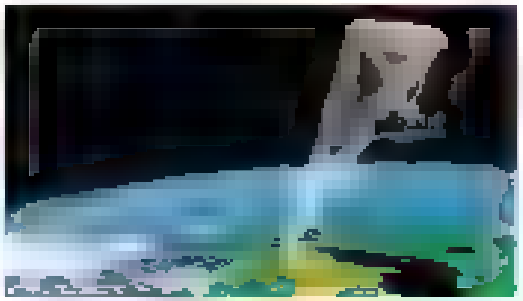


Figure 2.9: A Remote sensing satellite imaging Earth

researchers in studying coastlines, oceans, forests, crops, rivers or natural resources like minerals, oils, gases, etc, hidden under Earth

✓ Explain that how astronauts survive and research in space

Outer space is an extreme environment because of no air, less gravity intense temperature, pressure and hazardous radiations directly coming from the Sun. Such conditions can damage human cells and tissues if exposed for a longer duration. Large space stations have been built in space, which provide basic housing facilities and protection for humans to stay and live in space for a longer period. International Space Station (ISS) is an example of it. For further protection spacesuits have been designed, which are mandatory for every astronaut to wear when he or she moves out of the space station for work. Spacesuits supply oxygen to the astronauts to breathe while they are in the vacuum of space. They contain water to drink during spacewalks and other Extra Vehicular Activities (EVA). They protect astronauts from being injured by impacts of small bits of space dust. The suits even have visors to protect astronauts' eyes from the bright sunlight. However, inside space station astronauts may not need to wear any spacesuit. Living in a weak gravitational environment may cause human muscles to get weakened. Therefore, astronauts must perform intense workouts on specially designed exercise machines to keep their muscles strong.

Figure 2.10: An astronaut wearing a space suit and standing on the surface of the Moon

- ✓ Suggest ways to solve the problems that have resulted from space exploration

Problem of Increasing Space Debris

Like minerals, water and oxygen on Earth, outer space is also a huge natural reservoir. We need to protect it as we protect the other natural resources on Earth. Sadly speaking, where space exploration is a need of time for the advancement and betterment of our lives, an increase in the launching of spacecrafts, satellites and other space probes, has somehow polluted the nearby space around Earth. This pollution comprises non-operational space junk that remains in space after it has been utilized. It is commonly called Space Debris. Space debris can be as small as a paint fleck or a screw and as large as a fuel tank or even a non-functional satellite they are floating in space. Their collision with operational satellites, astronauts or space stations may endanger the safety of future space missions. In this regards following measures should be taken in order to remove/reduce the space debris

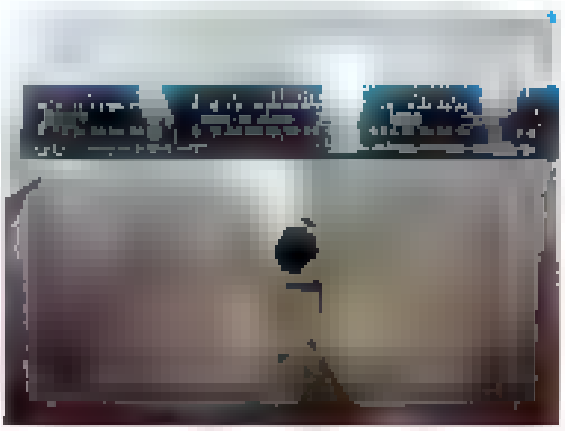


Figure 12.11: Damage caused by space debris on US Space Shuttle

- Minimizing the release of mission-related objects
- Safeguarding the physical integrity of astronauts, rocket bodies and spacecraft
- Measures to be taken to reduce the chances of collisions of satellites/space debris

Long Term Health Issues:

Upper space is not a habitable place for humans. Even though astronauts wear space suits and live inside a space station to protect themselves against all the dangers, yet a few of the dangers are still inevitable. It has been studied that living in space for

Figure 12.12: Twin brothers Mark and Scott Kelly. Mark spent a year on ISS in space to study long term space travel effects

longer duration may cause genetic changes in human body. This study was carried out on twin brothers, one of whom was kept on Earth, while the other was sent in space to live on International Space Station (ISS) for more than 300 days. The astronaut was brought back to Earth and he was diagnosed with certain changes in his genes i.e. damage to his DNA and reduction in his cognitive abilities.

- ✓ Identify the technological tools used in space exploration

Besides space probes, satellites and GPS, following are some of the other technological tools which are used in space exploration:

Satellite Launching Facility (SLF):

Launching a satellite, rocket, a space probe, or even astronauts into space, require a very large facility to be built on ground. This is called a Satellite Launch Facility. It is a technological advancement in itself. Hundreds of scientist and engineers working round the clock made it possible to safely launch space assets.

Figure 2.13: A satellite Launch Facility

Robots

To overcome the impact of the harsh space environment, scientists have manufactured different types of space robots for their use in space. This includes Fly-Bys, Rovers, Robotic Arms and Orbiters.

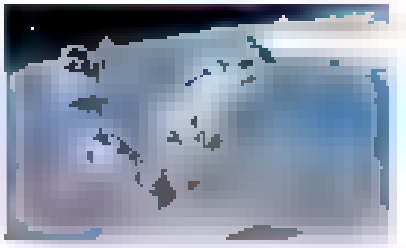


Figure 2.14: A robotic arm on ISS

Cameras:

Digital cameras are used with telescopes to take images of objects in space while they are also used with satellites to take high resolution images of the surface of Earth. Navigation and Hazard cameras are used by Satellite Control Stations established on Earth to guide robots, rovers and other digitally operated space probes to study, research and investigate outer space. Microscopic (Camera) is specifically designed for rovers and robots to take pictures of soil and rocks with very high precision to advance the study of planetary geology.

Telecommunication

Telecommunication is the transmission of images, sound or any other information from one place to another place by using wired or radio systems. The progress in space exploration has made telecommunication devices much more advanced. Today the communication is much faster and reliable as it can transfer a huge amount of data in very short time from a person to any specific location either from ground to ground or from ground to space and backward.

- Identify new technologies used on earth that have developed as a result of the development of space technology

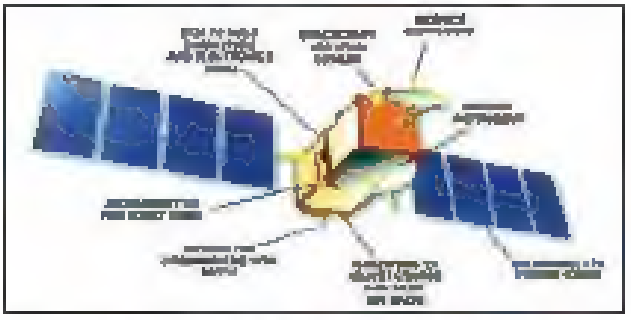
With the passage of time and increasing interest from countries around the world, more and more money is being invested in space exploration which in turn paving our way towards an advanced era of technology. Apart from revolutionizing our medical treatments and health procedures, exploration and research in space has also imparted our daily lives. A few of them are mentioned below:

- **Solar Cells:** They were primarily designed for their use in satellites and space probes. Now, this technology is used as an alternate source of electricity generation in our homes, offices, factories, etc.
- **WIFI:** The concept connecting two remote devices by using a WIFI connection was first applied by the scientists working on a large radio telescope. This modern technology is now being widely used everywhere around the world.
- **Tele education:** Satellite communication is being used to educate people living in remote and inaccessible areas. This concept is known as Tele-education.
- **Telemedicine:** It allows health care professionals to evaluate, diagnose and treat patients at a distance by using Satellite Communication.

✓ Design a space craft and explain its key features of design to show its suitability as a space craft.

Although there are many different parts a satellite or spacecraft consist of but the following are the most fundamental and found in almost every spacecraft.

- **Space Bus:** A box like container to be the body of the spacecraft. It holds the computer and electronics.
- **Solar Panel:** Something to supply electric power.
- **Cameras and other devices:** Some instruments to make scientific measurements or take pictures.
- **Antennas:** Some way to communicate with Earth (both to send data and to receive commands).
- **Micro Thrusters:** Some way to slow down, speed up, or change the direction of the spacecraft to keep it on course or in the right orbit.
- **GPS receiver:** Something to let the spacecraft know where it is and where it is going.



Activity:

By keeping in mind these parts of the satellite/spacecraft, design your own spacecraft. Using cardboard, color papers, scissors and glue make the model of your satellite. Perform following tasks.

- Describe the objectives of your satellite?
- Where do you want to send it? Mars or Moon? Explain your answer.
- Place different parts of satellite/spacecraft on board and explain their working.

SUMMARY

- Telescope is an instrument that helps to see distant objects clearly. There are two types of telescope; refracting and reflecting.
- White Light is the combination of seven different colours.
- A spectroscope splits white light into its seven component colours.
- A spacecraft is a man-made object developed to accomplish a certain task in space.
- Research and development from space exploration has given us several benefits in the field of health, medicines, weather forecasting, navigation, etc.
- Astronauts wear space suits in space.
- SLF, robots, cameras and telecommunication devices are some of the technological tools used in space exploration.
- Advancement due to space exploration is changing our everyday life. Solar cells, Wifi, tele-education and telemedicine are some of the common examples.

EXERCISE

1. Choose the correct answer.

(i) A Spectroscope is used to:

a) Detect sound waves emitting from a star.
b) Identify the chemical elements present in a star.
c) Converge light from a star to a point.
d) Identify the location of the star.

(ii) A Reflecting Telescope consist of:

a) A primary and a secondary mirror
b) Only a single mirror.
c) Many lenses.
d) A prism to split light.

(iii) Which Lunar Command Module took humans to the Moon?

a) Apollo 13.
b) Apollo 15.
c) Apollo 16.
d) Apollo 17.

(iv) MRI or CT scan resulted from the image exploration of:

a) Saturn.
b) Moon.
c) Jupiter.
d) Sun.

(v) A Global Positioning System (GPS) comprises how many satellites?

a) More than 15.
b) More than 20.
c) More than 30.
d) Less than 10.

2. Fill in the blanks:

a) The word telescope is a combination of _____ words.

b) Refracting telescopes uses _____.

c) _____ colour has largest wavelength in the spectrum of white light.

d) A spacecraft can be a _____ or it can be an _____.

e) MRI is a short form of _____.

f) Each GPS satellite makes _____ complete orbit in 24 hours.

3. Answer the following questions.

1. Define the following terms:

   a. Telescope.
   b. Refracting telescope.
   c. Reflecting Telescope.
   d. Spectroscope.
   e. Space Exploration.
   f. Space Debris.
   g. GPS.
   h. Remote Sensing.

2. How does a Refracting Telescope differ from a Reflecting Telescope?
3. Explain the construction and working of a Spectroscope.
4. Write down any five benefits of space exploration in the field of health and medicines.
5. What are the different technological tools used in space exploration?
6. Write a short note on the following:

   a. Astronaut surviving in space.
   b. Problems created by space exploration.
   c. Global Positioning System.

7. Write down the names and function of main parts of a satellite/spacecraft.